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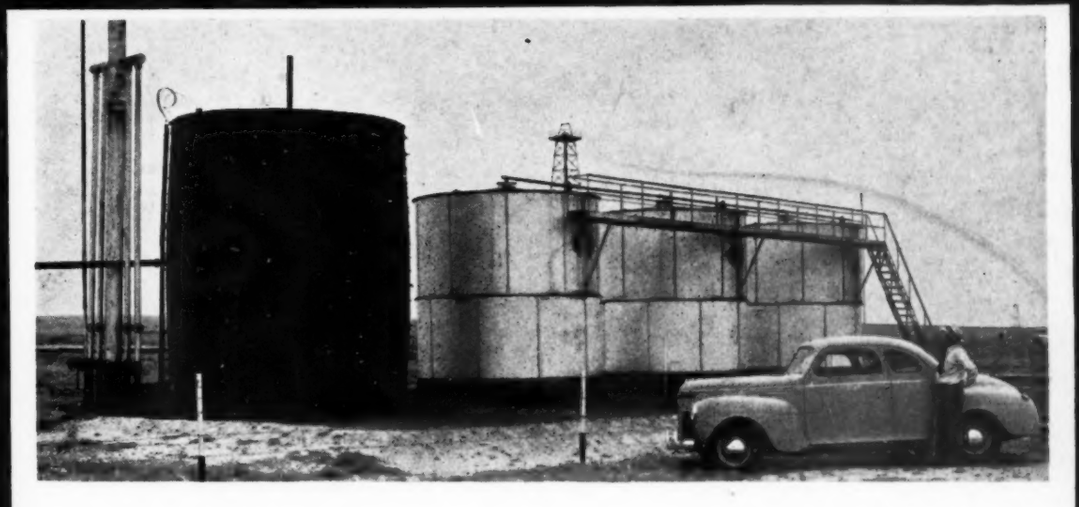

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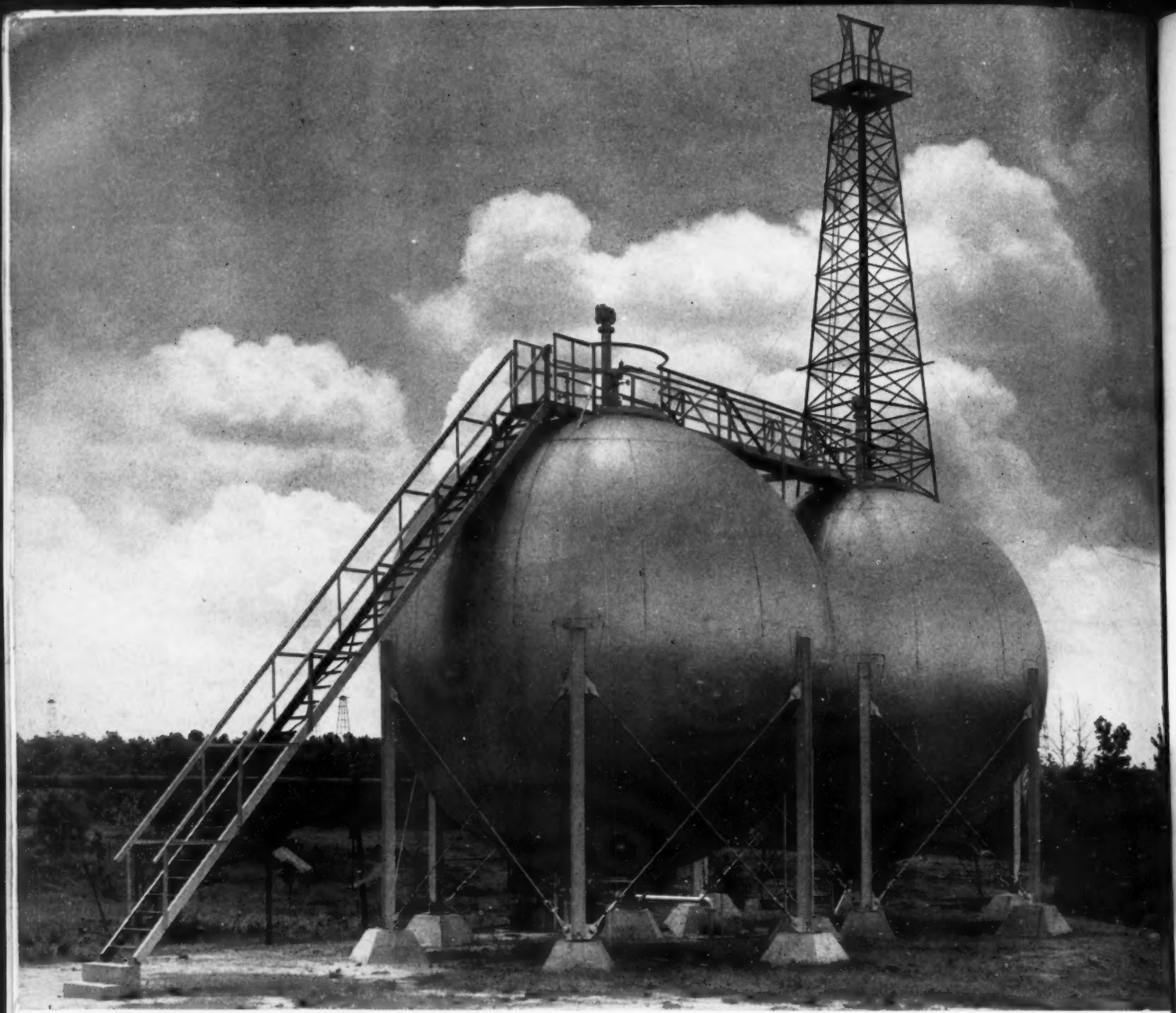

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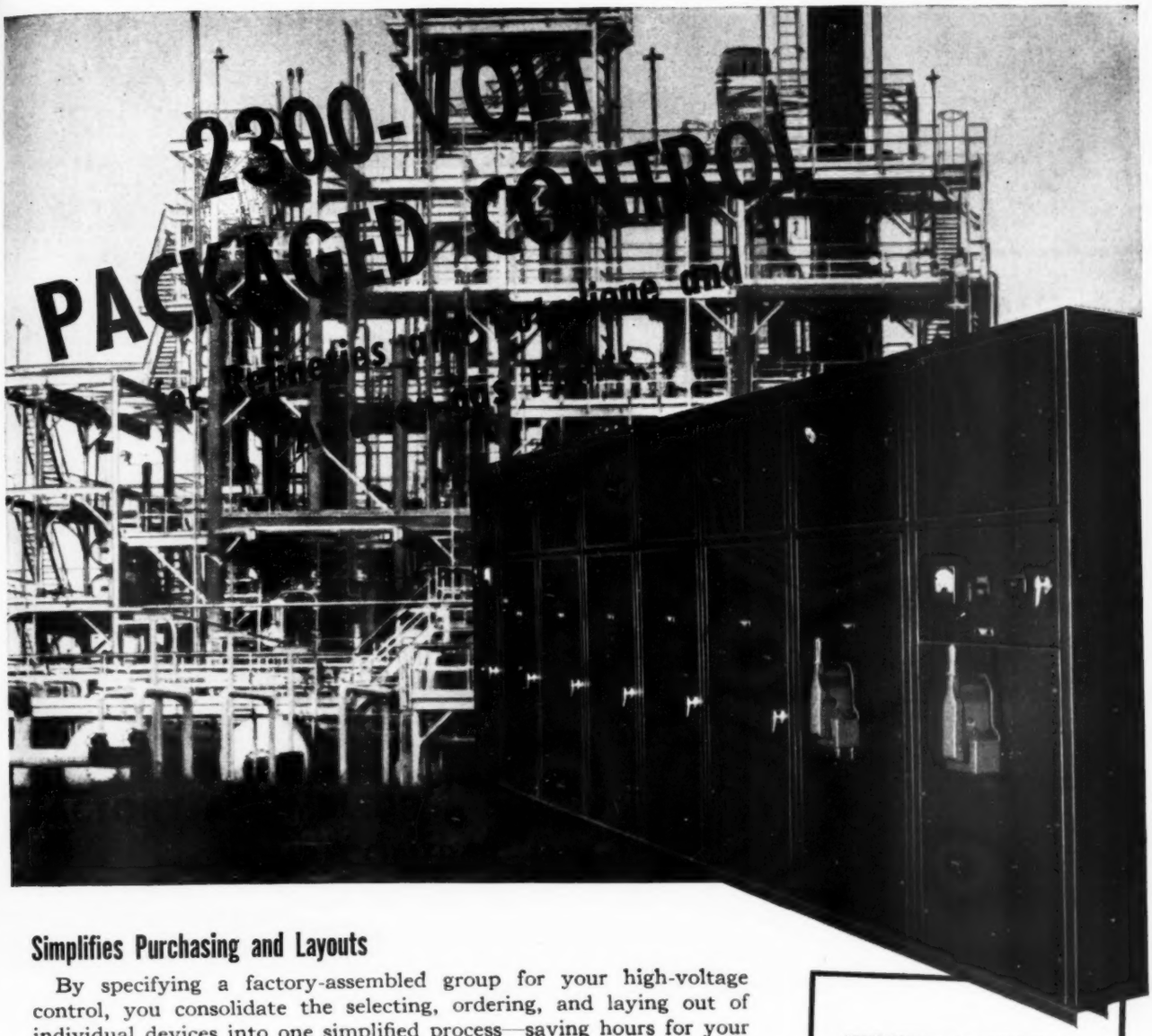

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THE Petroleum Engineer

VOL. XIV NO. 13

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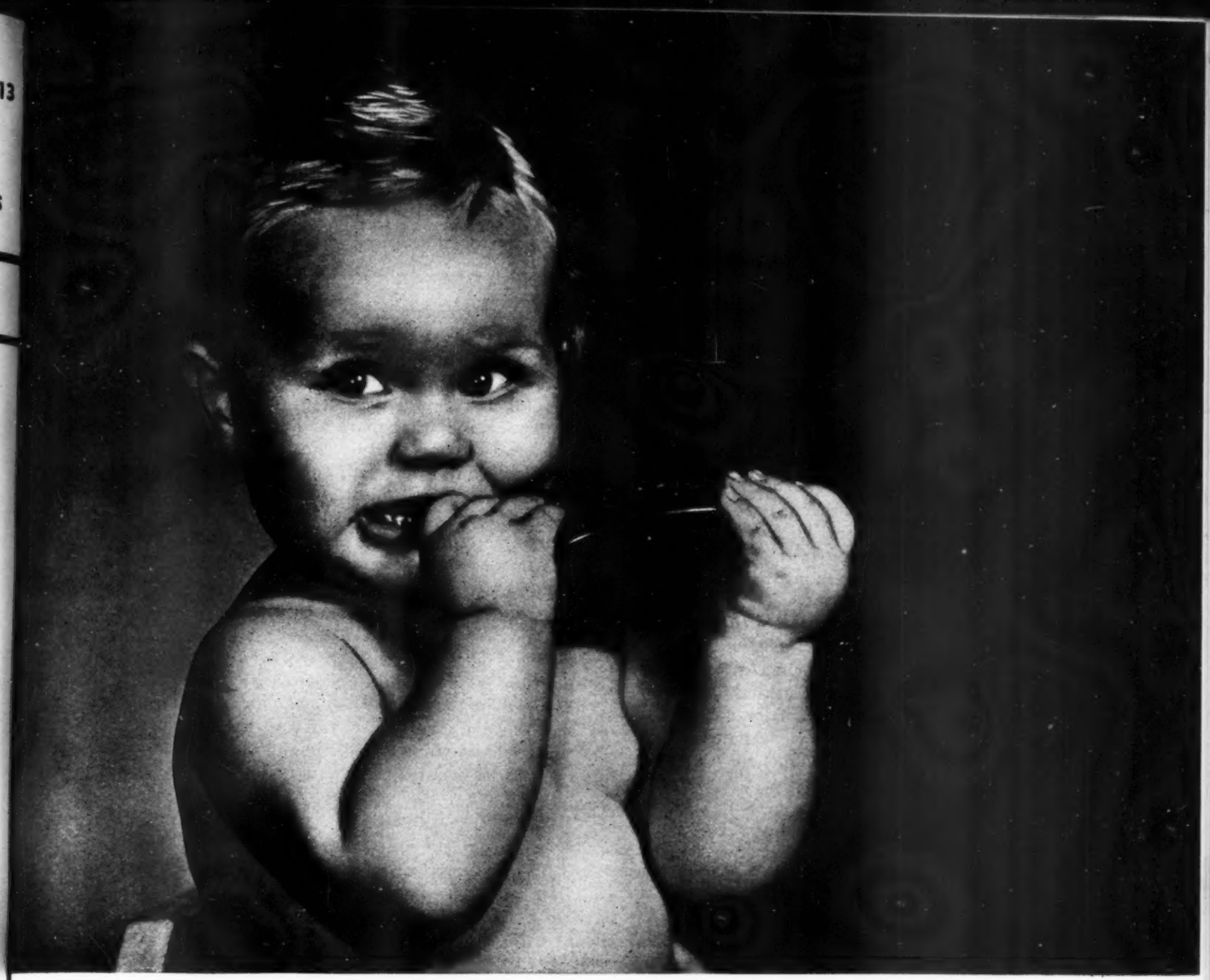

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The Course of Oil

by K. C. SCLATER

FILLING WAR NEEDS

Certified production rates announced by the PAW for September total 4,552,100 barrels for the United States. This is an increase over September, 1942, of nearly one-half million barrels a day. Most of the increase will fall on the oil fields of the southwest.

The PAW finds that it is not possible to increase crude oil production from fields that are accessible to transportation, without operating at production rates higher than efficient capacities. This would result in the irrecoverable loss of crude oil reserves and in lessened productive capacity in later months, and is not justifiable.

According to the latest reliable information, war requirements now take approximately one-third of all petroleum products produced in the United States. The Petroleum Administrator for War has informed the nation that unless there is some major change such as a sudden termination of the war, our direct military requirements of petroleum products may continue to increase to as much as 40 percent of our total output. This rapidly increasing demand is growing evidence of the precarious situation in which the country finds itself so far as its ability to supply petroleum for our future war needs is concerned. In a recent statement it has been pointed out by O. D. Donnell, president of the Ohio Oil Comany and chairman of District 2, PAW, that the necessary secrecy regarding "plans of the General Staff resulted in the oil industry being totally in the dark concerning the volume of petroleum required for the military forces. Thus, the industry has been obliged to go along from day to day using every resource at its command to meet the requirements placed on it by the military." He further points out that the "progress that has already been made in transportation and with the additions that are already in the making, the nation's crude oil production capacity is being rapidly utilized. The situation is further aggravated by the tremendous decline in the discovery of sufficient new large fields over the past few years to maintain an adequate backlog of crude oil reserves. Crude oil production is declining in the middle west and from present discovered fields is susceptible of increase only on the Gulf Coast and in West Texas. But due to the improved transportation facilities even these areas are being rapidly called upon to produce the maximum amount of crude possible.

"It should be remembered that when gasoline rationing was first instituted a little more than a year ago the action was taken as a means of conserving the nation's stock pile of crude rubber and tires. Rationing at that time had no relation to the availability of motor fuel.

"The factors heretofore mentioned mean that the petroleum situation in the United States has now reached the point where the industry can no longer guarantee sufficent crude oil to meet war and other essential civilian requirements unless petroleum products, particularly gasoline, domestic heating oils, and fuel oils are used conservatively. Gasoline production has fallen off and will continue to decline for the obvious reason that more and more of each barrel of crude oil that formerly went into civilian automotive gasoline is now going into 100-octane aviation gasoline, toluene for TNT munitions, butadiene for synthetic rubber, diesel oil for the Navy, and distillates for reprocessing in catalytic cracking plants for the manufacture of war products.

"The situation is critical. If we are to avoid serious consequences, it is imperative that the people, regardless of what group they may be a part, whether farmers, office workers, war workers, or whatever their position may be, must recognize that our country is engaged in the most deadly conflict of all times, and that if we are to come out of this holocaust with anything left we must use wisely and conserve all of those things and facilities which are so vital in the successful prosecution of the war and at the same time to our everyday life at home."

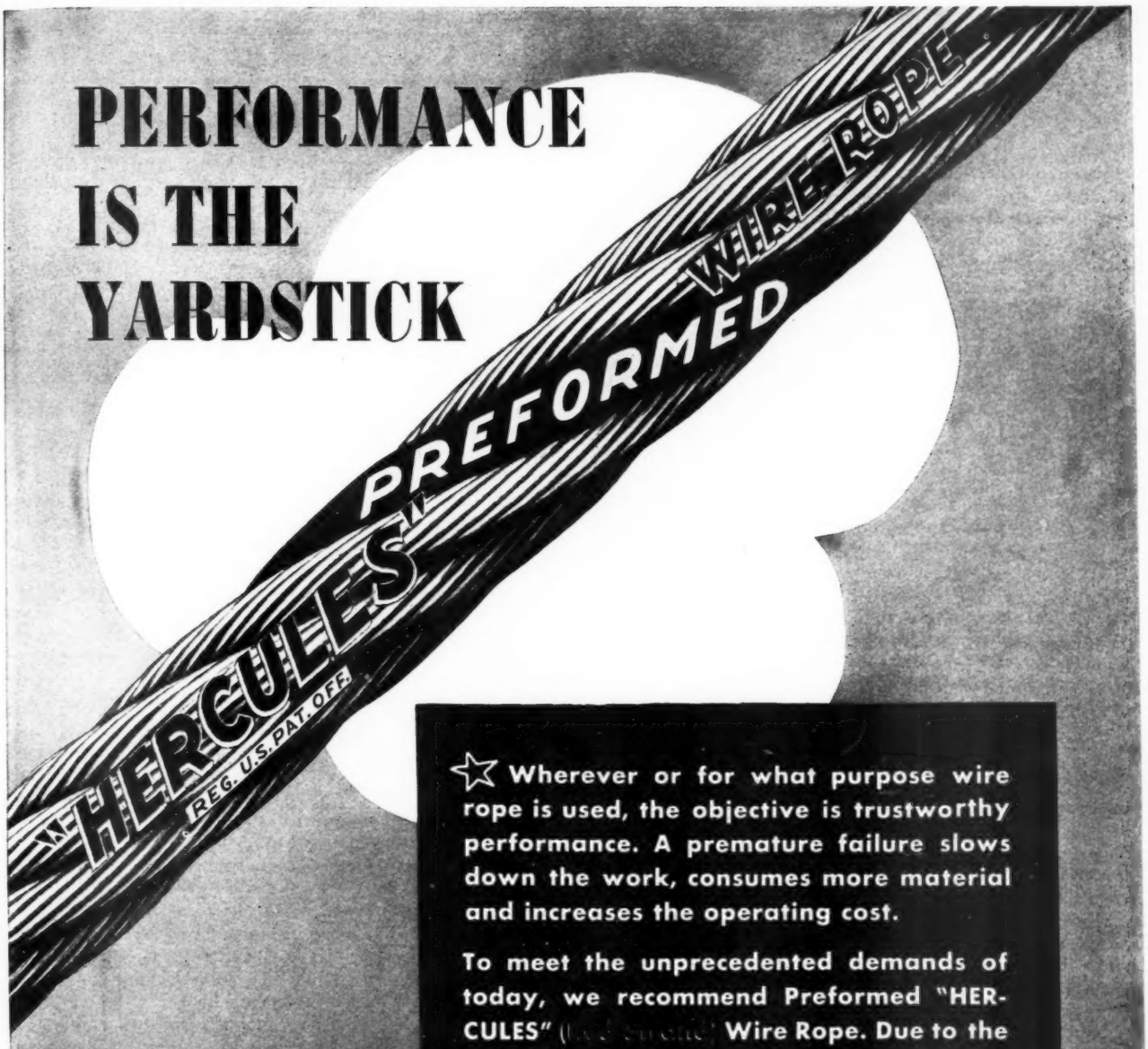
In the current issue of *Mining and Metallurgy* Harry C. Weiss, president of the Humble Oil and Refining Company, discusses "Crisis in Crude Oil?" At our average current rate of crude oil production of 4,150,000 barrels per day, we shall be 250,000 barrels a day short of supplying expected average crude oil needs of 4,400,000 barrels per day in 1944. How can the supply of crude oil be increased by 250,000 barrels per day? By drawing excessively on fields now producing and endangering our present reserves, by finding new fields, or by importing foreign oil. Failing these the public must be called upon for further sacrifices by refraining from all non-essential use of petroleum products.

All indications point to the probability of our having to resort to producing our fields beyond capacity thus endangering our present reserves, to importing foreign oil, and, if necessary, to placing further restrictions on the use of petroleum products by the public. Unless a general increase in the price of crude oil is granted, there is little likelihood that a shortage of crude oil can be relieved by the discovery of adequate new fields.

DESIGN AND PERFORMANCE

On a recent 24-hour test run a total of 328,000 barrels of Texas crude oil was delivered through the western leg of the "Big-Inch" line. This confirms the preliminary estimate when the "Big-Inch" line was designed that it would have a top capacity of at least 325,000 barrels a day during the warm, summer months. It is a gratifying performance record of which engineers who designed the line can be justly proud.

PERFORMANCE IS THE YARDSTICK



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Highlights IN OILDOM

Drake Well 82 Years Old

Because of the war the 82nd anniversary of the drilling of the Drake Well, which discovered oil in the United States, went unobserved August 27. Drilled on Oil Creek, now a part of Titusville, Venango County, Pennsylvania, the well produced from a depth of 69½ ft., pumping an average of 20 bbl. of oil a day.

Magnesium from Oil Field Brines

The possibilities of extracting magnesium from oil field brines are discussed in a report published by the Kansas Geological Survey at the University of Kansas, Lawrence. Investigation of the magnesium content of oil field brines was instituted more than a year ago. During the course of the investigation 79 oil fields were visited by W. H. Schoewe of the survey staff, and analyses of more than 200 samples of brines were made by R. Q. Brewster and Calvin Vander Werf of the chemistry department of the university.

The report suggests that more detailed study will show the practicability of extracting magnesium from oil field brines as an auxiliary phase of the oil industry, although the extraction of magnesium from these brines is probably not feasible in Kansas as a specialized industry. Such an auxiliary would help to defray the cost of salt water disposal in some oil fields.

A feature of special interest in this report is the tabular representation of the chemical properties of brines, depths to and names of producing formations, and quantities of brine produced.

High Octane Equipment for Mexico

The United States has promised Mexico equipment for the construction of a high octane gasoline plant, according to Efrain Buenrostro, manager of Petroleos Mexicanos, the government oil administration. Buenrostro, who recently returned to Mexico City from a trip to the United States, where he conferred with government officials and oil executives, said plans for the construction of the plant and other proposed projects are being studied.

Texas Discovery Allowable Rule Eased

To encourage the discovery of new oil reserves in Texas the Railroad Commission has amended its order fixing allowables for discovery wells to extend the privileges to groups or clusters of wells. The original order was dated January 15, 1943, and the amendatory order was effective August 17.

The original order adopted a graduated scale for allowables for discovery wells ranging from a minimum depth of 1000 ft. with 20 bbl. daily to 300 bbl. for wells up to 15,000 ft. in depth, there being 15 graduations.

The new order provides that each such group or cluster of wells shall consist of the first well in such group and all other wells that are completed within a radius of less than one-half mile of the first well.

The discovery allowable as applied to any such group of wells shall have its allowable beginning on the date that oil is first satisfactorily marketed from any well in the group and shall, in no event, apply for more than 18 months thereafter, beginning from the date of each well's having a satisfactory outlet to market.

Selling oil from any well is evidence of a satisfactory market for that well, but does not commit the owner of any other well. The completion of a sixth well at a distance of less than one-half mile from the discovery well of any group shall terminate the discovery allowable for all wells in the group.

Any producing well completed at a distance in excess of one-half mile from the nearest well that produces from the same zone may be claimed to be the discovery well around which a group or cluster of wells may be started.

In order to be assigned to such a group or cluster, all subsequent completions must be within a radius of less than one-half mile from the well that established the group or cluster and in addition must be more than one-half mile from any well used to establish any other group or cluster of wells.

Low Price of Crude Cuts Production—PIWC

The Petroleum Industry War Council, in a sharply worded report, charges that low ceiling prices for crude oil in the face of greatly increased costs is the principal obstacle to obtaining adequate supplies of oil for the war and for civilian needs.

"The situation has been permitted to become progressively worse," the report said. "The inexcusable delay in granting proper price increases from the abnormally low level at which they were frozen has occasioned loss of manpower to other industries, loss of production of petroleum, and accentuated restrictions on the use of its products for essential civilian and industrial use."

The council recalled that it had recommended higher prices for crude oil "long ago. Since then, costs of production have mounted to the point where the price which might have been adequate months ago is inadequate now."

Use Your Sense—Lend Your Dollars

This is your war, the war of every American, particularly the war to preserve values for every executive and employee of industry—whether in shop, in mine, or on the land.

The men on the battlefronts are doing their share. Many of our fighting men will give their lives; all of them have given up their homes and families and jobs. They are ready to die, if need be, in order to preserve a country where life is worth living. Isn't it little enough sacrifice for civilians—either private individuals or corporations—to help finance this war, when our own sons are giving so much more than money?

The Third War Loan Drive, now in progress, seeks to raise the tremendous amount of 15 billion dollars throughout the nation. That means that every adult has a personal goal of one extra $100 war bond during the September drive, if the goal is to be attained.

What is your share? Only you can answer that question. Maybe you as an individual can invest far more than that extra $100 that has been set as an average. Regardless of the amount you are able to invest, you are not doing your share until you have bought war bonds to the limit of your ability.

This war is now costing slightly more than $3500 every second! Americans are going to pay for it—are paying for it now—in increased taxes and by lending their money to the Government for war bonds. Every adult in America must help to carry his financial burden, must contribute his or her share to the amount needed to finance the invasion and supply our armed forces with the materials of war.

Your money, loaned at interest for war bonds, will do four things: It will supply the needed arms and equipment to back up our fighting men; it will help to curb inflation; it will insure personal security for you; and after the war has been won those same war bonds will represent purchasing power that will supply the goods, services, and jobs that will be needed by the soldiers, sailors, and marines who will return to civilian life.

Have you bought your war bonds yet?

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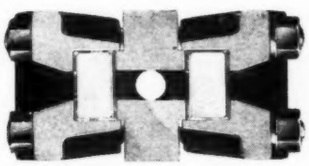

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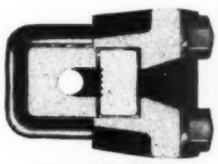

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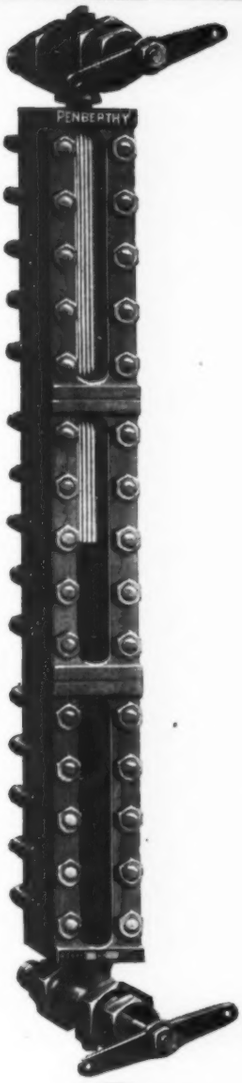

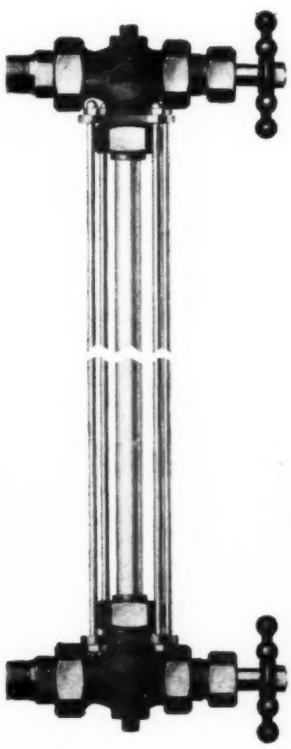

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MAJOR *Refining* ACTIVITIES

A LARGE butadiene refinery built from scrap materials has been placed in operation by the Lion Oil Refining Company of El Dorado, Arkansas. The plant was constructed with materials salvaged from equipment warehouses, shut down refineries, and junkyards.

Among the first of its kind to go into operation, the plant employs a new process that has been recently developed. It is situated near South Arkansas' sour gas fields, themselves utilized only within the last few weeks.

Announcement has been made of the incorporation of the Tulsa Chemical Company with headquarters at Tulsa, Oklahoma. This company was organized for the manufacture of anhydrous hydrofluoric acid, a catalyst used in the production of high octane gasoline. Interest in the company is divided among the Pennsylvania Salt Manufacturing Company of Philadelphia, Pennsylvania, the Mahoning Mining Company of Rosiclare, Illinois, and the Ozark Chemical Company of Tulsa.

The officers of the new organization are:

President, George B. Beitzel, vice-president of Pennsylvania Salt Manufacturing Company; vice-president, C. O. Anderson, assistant to president, Ozark Chemical Company and technical director, Ozark and Mahoning; treasurer, L. A. Smith, vice-president and treasurer of Pennsylvania Salt Manufacturing Company; assistant treasurer, C. M. Bush, assistant treasurer of Ozark Chemical Company; and secretary, S. H. Davis, vice-president of Ozark Chemical.

An anhydrous hydrofluoric acid plant is being erected at Tulsa, and production should begin during the month of October, 1943.

Toulene, basic ingredient of high explosives, is being made in large quantities in a new $6,800,000 unit at one of The Texas Company's refineries in the Chicago area. The first to be constructed in Illinois, the new unit was built under an army ordnance contract; its capacity is, of course, a military secret.

One of the cuts from ordinary straight-run gasoline, which is manufactured elsewhere in the plant, is the raw material used in the difficult and costly process of extracting toluene. The finished product is a water-white, harmless looking fluid. It is shipped to other plants to be manufactured into TNT (trinitrotoluene) by the nitration process.

Congress will be asked to authorize three semi-commercial plants for the refining of gasoline from coal and oil shales, according to Representative Jennings Randolph, Democrat from West Virginia, chairman of the house mines sub-committee. The plants are estimated to cost $30,000,000. One would be built in the Rocky Mountain region, a second in the eastern bituminous coal area, and a third at an undecided site.

Work will begin soon on construction of a hydrogenation unit at the Baytown, Texas, refinery of the Humble Oil and Refining Company. The building contract has been let. The new unit will cost $2,000,000. The hydrogenation process is for production of high octane gasoline.

Additional water cooling facilities at the Baytown refinery of the Humble Oil and Refining Company has been ordered deferred until after the war. Preference ratings were revoked after a review of the situation by the War Production Board.

First production of synthetic rubber in southwest Louisiana began recently at the huge Cities Service-Firestone plant at Lake Charles. John W. Thomas, Firestone chairman, said the plant would have an annual capacity of 60,000 tons. It was built for the Defense Plant Corporation.

Phillips Petroleum Company is constructing a new furnace black plant in the Texas Panhandle for production of a new type material adapted particularly to manufacture of synthetic rubber automobile tires. After several years of research the new furnace black, named "Philblack", will be the means of giving high tensile strength and high resistance to abrasion to synthetic rubber, the company said. The plant is being built adjacent to the butadiene plant that was designed and is operated by Phillips for the government.

Serious damages were caused by a Texas hurricane to the Houston refinery of the Shell Oil Company, Inc., at Deer Park, but unprecedented speed restored the facilities to full operating capacity in less than three weeks. The hurricane blew down a giant water-cooling tower that stopped all generators in the plant and production ceased.

With the aid of the Fluor Corporation, Ltd., of Los Angeles, a contracting firm that built the cooling tower, work on reparation began almost immediately. Employees slept on the refinery premises to save time. The ODT, the Southern Pacific railroad system, and oil field suppliers cooperated in rushing the work through. Parts in Los Angeles were loaded and hooked to fast passenger trains to speed shipment. Partial production began in a few days and regular schedules were resumed in three weeks.

Speed-up in the construction of 100-octane aviation gasoline plants is being planned by the Petroleum Administration for War. Ralph K. Davies, deputy administrator, has announced an expansion of the construction division to be headed by Max B. Miller, New York City. A native of Bloomington, Indiana, Miller has had more than 20 years experience as a construction official. The accelerated program is designed to assure the air forces of the United Nations that they will have an adequate supply of 100-octane aviation gasoline at all times.

Crude Runs to Stills, Production[1] and Stocks[2] of Motor Fuels
Week Ended August 28, 1943
A.P.I. Figures
(Figures in thousands of bbl. 42 gal. each)

DISTRICT	DAILY REFINING CAPACITY		CRUDE RUNS TO STILLS[3]			
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	Potential Rate	Percent Reporting	Daily Average	Percent Operated	Total Production	Total Stocks
Appalachian	2,444	88.7	2,173	88.9	13,843	69,937
District No. 1	130	83.9	108	83.1	555	2,676
District No. 2	47	87.2	57	121.3	299	1,190
Ind., Ill., Ky.	824	85.2	741	89.9	4,589	25,539
Okla., Kan., Mo.	416	80.1	324	77.9	2,096	10,623
Rocky Mountain						
District No. 3	8	26.9	8	100.0	65	100
District No. 4	139	57.7	86	61.9	577	2,429
California	817	89.9	730	89.4	4,913	75,652
TOTAL U. S.— AUGUST 28, 1943	4,825	86.4	4,227	87.6	26,937	188,146
TOTAL U. S.— AUGUST 21, 1943	4,825	86.4	4,046	83.9	25,925	186,901
U. S.— AUGUST 29, 1942			3,705		23,184	212,657

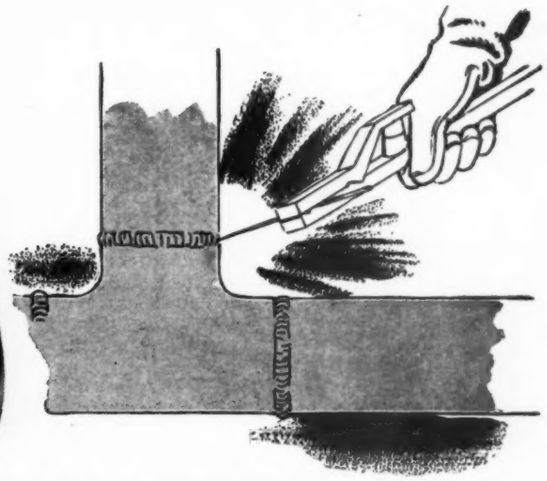
*At the request of the Petroleum Administration for War.

[1]Production—total of gasoline at refineries including natural and blended; kerosine, gas oil and distillate fuel oil, and residual fuel oil.

[2]Stocks—at refineries, bulk terminals, in transit, and pipe lines of finished and unfinished gasoline; kerosine, gas oil and distillate fuel, and residual fuel oil.

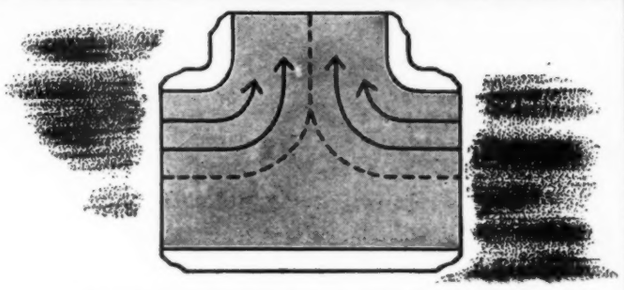
[3]Figures on production and stock include reported totals plus an estimate of unreported amounts and are therefore on a Bureau of Mines basis.

How TUBE-TURN welding tees improve piping construction



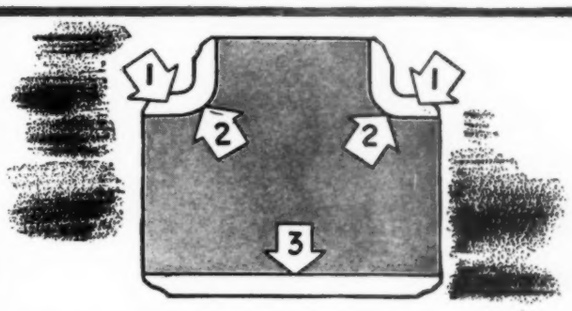
LONGER OUTLETS SPEED WELDING

More room for easier manipulation of rod means faster welding and better, sounder welds.



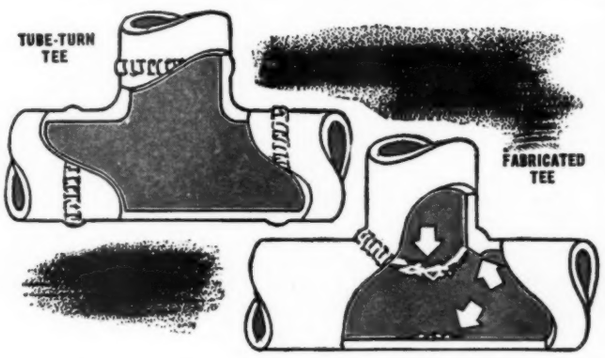
SMOOTH FLOW, LESS PRESSURE LOSS

Smooth inner walls assure even flow and reduce wear. Rounded inside crotch reduces pressure loss.



EXTRA STRENGTH AT STRAIN POINTS

Added thickness at top of run (1), crotch (2) and bottom (3) strengthens points of highest stress.



NO FABRICATION FAULTS

Fabricated tees often have jagged corners, crude welds, and slag. Tube-Turn Tees eliminate these.

FASTER, EASIER ALIGNING

Accurate bevels, plus I.D. and O.D. that exactly match the pipe, make aligning simple and speedy.

TUBE-TURN
NO. 8 OF A SERIES
HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY
The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

MAJOR *Oil Field* ACTIVITIES

▶ **Illinois.** Two producing zones are possible in The Texas Company No. 1 Mayes, CE½ NE SE 10-1n-10e, in Edwards County. The discovery well had a good showing of oil in the Aux Vases at 3180-91 ft. and on a drillstem test of the Rosiclare at 3247-56 ft. showed 120 ft. of oil, 60 ft. oil cut mud and some water.

▶ **Kansas.** West-Kan Drilling Company No. 1 Keller, discovery well in the Keller pool of Rice County, is completed for an initial potential of 249 bbl. of oil daily. In the SW NE SW 3-19-9w, the well produces from the conglomerate at 3244 ft.

▶ **Oklahoma.** Logan County apparently has a new pool in the Wilcox sand, which was penetrated at 4701 ft. and cored 11 ft. Eason Oil and Sunray No. 1 Cather, NE NW NW 15-16-2w, the discovery well, is southeast of Guthrie.

▶ **Texas.** Discovery of a new deep oil field for the Rio Grande Valley is believed to be imminent. Reports state that the Continental Oil Company No. 1 Cameron, in Survey 138, Starr County, had made 80 bbl. of oil on a 10-hr. test of sand near 4190 ft. Other tests are being made at various depths.

▶ **New Mexico.** The Cosden Petroleum Corporation and C. T. McLaughlin No. 1 State, C NW NE 7-17s-33e, two miles northeast of the Maljamar pool of Lea County, has found new pay at 4190-4213 ft. Reported to be making 150 bbl. a day, the well will be put on the pump as there is an insufficient volume of gas in the zone.

▶ **Oklahoma.** Mid-Continent Petroleum Corporation No. 1 Fowler, SWC NE 33-12-4e, southeast of Meeker has reopened the Meeker oil pool. The well made 150 bbl. in 24 hr. flowing through perforations from 5542-48 ft. Tubing is being run to give the producer a thorough test.

▶ **Mississippi.** A California Oil Company well about 12 miles east of Natchez in Adams County has found wet gas condensate at high pressure at 10,300 ft., indicating a probable fourth new oil field in the state this year. The well is on land belonging to the Natural Gas Company of Louisiana.

▶ **Illinois.** A new Aux Vases sand producer in the Beaver Creek area of Hamilton County was brought in by the National Associated Petroleum Company. No. 1 Redstock, C SW NW 26-4s-7e, had sand at 3280-92 ft. and a drillstem test produced 2000 ft. of oil in 30 min.

▶ **Texas.** A new dual sand gas and condensate pool has been discovered in Colorado County, near Chesterville. On a 5-hr. drillstem test in the Wilcox sand at 9500-40 ft. Magnolia Petroleum Company No. 1 Anderson, G. H. and H. Survey, flowed 7½ bbl. of water-white condensate during the last 45 min. In the Cockfield sand at 6850-60 ft. the well showed gas and condensate.

▶ **Louisiana.** The Redell pool was opened by Danciger Oil and Refining Company No. 1 Hattie Harris, 22-4s-1e, in the Ville Platte area of Evangeline Parish. The well tested a deep zone from 12,116-22 ft., flowing 100 bbl. through ⅜-in. tubing choke.

▶ **Kansas.** Dickinson County has its first oil pool, the Bonaccord, opened at Ingling and Parker No. 1 Miller, CS½ SE SW 30-14-1e, 12 miles east of Salina. It was given an initial rating of 223 bbl. from the Burgess at 2483-2518 ft.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	$ .88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.93-1.36
Coalinga	.73-1.13	North Louisiana	.98-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	1.05-1.07		
New Mexico	.70-1.15	Indiana	.85-1.25
Texas		Ohio	
North Central	.97-1.25	Lima	1.50-1.60
Panhandle	.70-1.12		
West Texas	.80-1.27	Michigan	1.24-1.44
Gulf Coast	.93-1.48		
Darst Creek	1.14	Pennsylvania	
East Texas	.80-1.27	Bradford	3.00
Talco	.79	Southwest	2.65
Kansas	.93-1.25	Eureka	2.59
Oklahoma	.75-1.25	Buckeye	2.30
Arkansas	.94-1.36	Corning	1.31

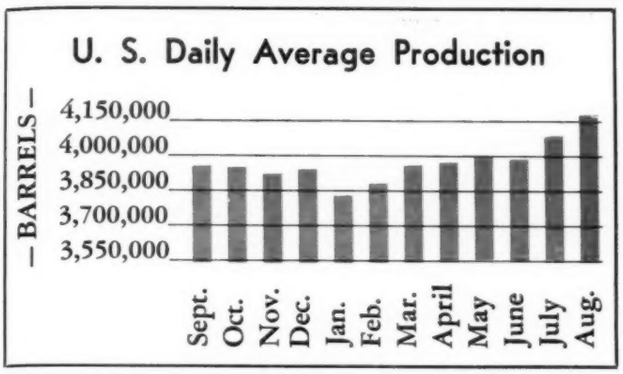
DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.
(Figures in bbl. of 42 gal. each)

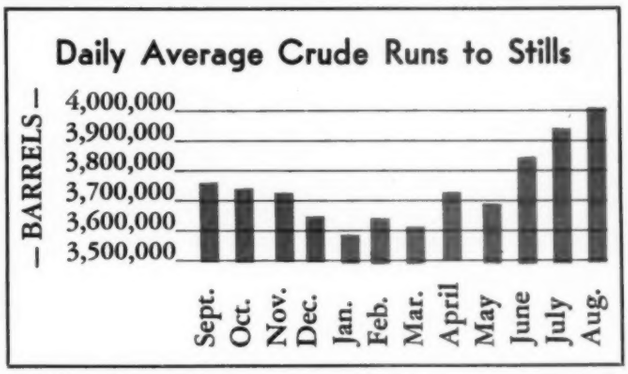
	[1]P.A.W. Recommendations August	Week Ended Aug. 28, 1943	Week Ended July 31, 1943	Week Ended Aug. 29, 1942
Oklahoma	347,000	[2]326,200	333,500	379,600
Kansas	300,000	[2]297,600	306,150	290,050
Nebraska	2.100	[2] 1,800	2.200	3,200
Panhandle Texas		98,000	90,400	88,900
North Texas		140,400	137,700	136 400
West Texas		258,400	245,600	226,800
East Central Texas		129,950	128,000	87,150
East Texas		371,000	371,000	363,000
Southwest Texas		239,050	230,000	200,750
Coastal Texas		474,450	412 900	309,750
TOTAL TEXAS	1.817,000	1,711,250	1,615,600	1,412,350
North Louisiana		81,900	84,500	97,650
Coastal Louisiana		268,500	264 000	240,550
TOTAL LA.	356,300	350,400	348,500	338,200
Arkansas	75,500	76,350	77,400	71 050
Mississippi	50,000	52,200	53,250	75 550
Illinois	222,800	211,800	218,850	268.050
Indiana	14,000	14,700	13,850	16,950
Eastern (Not incl. Ill., Ind., Ky.)	86.500	73,950	81,050	85,600
Kentucky	25,000	22,600	25,050	10,900
Michigan	60,100	56,950	57,900	61,800
Wyoming	98,000	96 850	100,000	90,900
Montana	23,300	21,350	21,450	22,900
Colorado	7,000	7,300	7,300	6 550
New Mexico	110,000	105,050	103,950	95,300
TOTAL EAST OF CALIF.	3,594,600	3.426,350	3,366,000	3,227,950
California	830,000	769,900	767,300	736,400
TOTAL U. S.	4,424,600	4,196,250	4,133,300	3,964,350

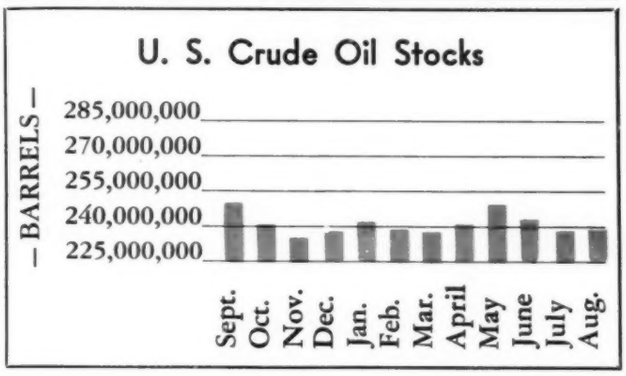
[1]P.A.W. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline and allied products in May, 1943, as follows: Oklahoma 26.600; Kansas, 5,100; Texas, 107,400; Louisiana, 18,400; Arkansas, 3,800; Illinois, 11.100; Eastern (not includ ng Illinois, Indiana or Kentucky), 7,300; Kentucky, 2,600; Michigan, 100; Wyoming, 2,100; Montana, 300; New Mexico, 5,100; California, 45,300.

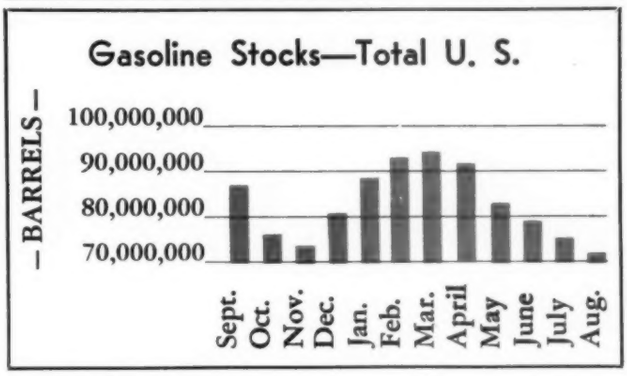
[2]Oklahoma, Kansas and Nebraska figures are for week ended 7 a. m. August 26, 1943.

PETROLEUM *Statistics* AND FIELD *Operations*









Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for August, 1943

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
Eastern Texas	24	9	6	....	3500-3700	2	40	Rotary
Gaines County	3	2	5	....	4400-5584	2	22-35	Rotary
Hockley County	9	8	5	....	4800-6850	2	20-30	Rotary
Ector County	7	5	5	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	13	10	6	....	1700-3900	2	40	Rot.-Cab.
Nueces County	6	6	3	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	4	3	4	....	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	2	2	2	....	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	6	6	8	....	2150 4125	2 or 3	38	Rotary
KANSAS								
Russell County	9	8	3	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	6	4	7	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	5	5	4	....	3250-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	186	87	61	76	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	7	7	7	....	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	14	10	15	10	1840-11,450	3 or 4	14-30	Rotary
Wilmington County	5	4	9	7	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for August, 1943

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1942 (In Barrels)
	August	July	August	July	August	July	August	July	August	July	
Arkansas	25	16	15	12	14	10	10	10	20	16	26,560,000
California	146	95	118	83	53	48	44	36	52	56	248,250,000
Illinois	186	161	87	97	30	54	61	35	76	108	105,768,000
Indiana	37	8	24	5	26	15	6	4	11	4	6,680,000
Kansas	162	143	91	109	57	47	24	22	18	13	96,920,000
Kentucky	51	29	22	20	20	16	....	....	....	....	4,503,000
Louisiana	65	78	40	64	38	18	10	11	24	22	125,450,000
Michigan	66	51	38	37	24	20	15	10	20	....	21,568,000
Mississippi	6	7	2	....	....	....	....	....	....	....	27,605,000
Montana	18	22	11	18	....	....	6	....	....	....	8,998,000
Nebraska	....	2	....	1	6	3	....	....	....	....	1,367,000
New Mexico	20	18	10	14	14	17	....	....	....	....	31,875,000
New York	110*	104*	110*	83*	57	71	27	....	....	....	5,132,000
Ohio	90	89	45	71	36	42	22	....	....	....	3,480,000
Oklahoma	151	111	85	85	38	36	24	18	62	63	138,750,000
Pennsylvania	252*	196*	246*	98*	171	99	....	....	....	....	17,256,000
Texas	425	306	245	226	341	281	271	228	301	286	476,560,000
West Virginia	77	47	71	38	27	24	6	3	21	19	3,780,000
Wyoming	12	8	9	....	7	4	4	1	19	7	32,778,000
Total	1899	1491	1269	1061	959	805	530	378	624	594	1,383,280,000

*Includes water-intake and pressure wells.

MAJOR *Pipe Line* ACTIVITIES

APPROVAL has been granted by the War Production Board for allocation of steel and other critical materials needed for the construction of a pipe line from southwestern gas fields to the Appalachian manufacturing area. One condition was that the line must be built by the winter of 1944-45 to prevent interruption of war production in the plants where the natural gas would be used as fuel.

It is now up to the Federal Power Commission to decide whether the line shall be built and by whom. Applications have been filed by two companies for permission to construct the 1200-mile natural gas line and the WPB has stated that neither proposal held any advantages over the other as to the use of critical materials. It was stated that each pipe line will require about 215,000 tons of steel for construction.

Hope Natural Gas Company of Clarksburg, West Virginia, would construct and operate a 22-in. line from the Hugoton natural gas field in southwestern Kansas to the company's existing facilities in Kanawha County, West Virginia, a distance of 1140 miles. Hearing on the application, which has been twice postponed, will be opened September 21.

The Tennessee Gas and Transmission Company also has filed with the FPC an application for certificate of convenience and necessity covering construction of a line from Corpus Christi, Texas, to a terminal point at Cornwall Station, West Virginia, a distance of approximately 1400 miles.

Specifications of the two lines call for capacities of 200,000,000 cu. ft. of gas daily. Either can be increased to 300,000,000 cu. ft. daily by installing additional pumping equipment. WPB termed the proposed pipe line "an essential part of the war program."

◆

Work is almost completed on a pipe line from the so-called Prairie Point pool, Platt County, Missouri, to the North American bomber plant at Fairfax, at the northeast edge of Kansas City. The pool was opened in September of 1940 and will now be put to war use. Missouri Valley Gas and Oil Company discovered the pool and the dozen producing wells drilled have a total initial potential of approximately 10,000,000 cu. ft. of gas daily.

◆

A new organization, War Emergency Tankers, Inc., has been formed by a group of leading oil companies to operate the government's rapidly growing tanker fleet. The move was made at a request from the War Shipping Administration, which is expected to enter into a general agent's agreement with the new company.

Companies sponsoring the corporation will be its principal subagents. They will use their present staffs for operation and maintenance of tankers assigned to them by the concern. Included in the organization are: Atlantic Refining Company, Pan American Petroleum and Transport Company, Socony-Vacuum Oil Company, Inc., Standard Oil Company of New Jersey, Sun Oil Company, The Texas Company, Tide Water Associated Oil Company, and Kirlin, Campbell, Kickox, Keating and McGrann.

◆

Repairs have been completed to a slight break in the New York Harbor branch of the "Big Inch" pipe line from East Texas, the Petroleum Administration for War has announced. The break occurred in a joint, which split under pressure, and not in the pipe proper. Only a small amount of oil was lost, as the flow was diverted immediately into the southern branch of the line, between Phoenixville, Pennsylvania, and the Philadelphia refining area.

Scene of the break was east of Doylestown, Pennsylvania, near where the 20-in. branch crosses the Delaware River. Repairs were completed within 24 hr. A similar break was experienced near the same location a week before, but was quickly repaired. Both breaks were in the 20-in. branch line, and not in the 24-in. main line.

◆

Petroleum Administration for War has refused to grant permission for a 114-mile 10-in. oil pipe line to be built through the New England states from Albany, New York, to West Boylston, Massachusetts, with a 51-mile 8-in. extension to Breed's Island, near Boston. Disapproval was stated to be based on the fact that existing transportation facilities now are adequate to provide the entire East coast with its full share of the available petroleum supplies for civilian consumption.

◆

A pipe line gathering system to connect the Rado refinery at McAllen, Texas, with five oil fields in Hidalgo and Starr counties will be started soon. The oil pipe line will cost $50,000 and is scheduled to be finished before the end of September. The Rado lines will connect with those of the Continental Oil Company and may be operated in reverse, so that if Rado gets a surplus of crude, it can be pumped back into the Conoco trunk lines going to tidewater on the Gulf.

◆

The first concrete oil barge built at the McCloskey and Company San Jacinto Shipyard in Texas, was launched in San Jacinto Bay at a ceremony attended by thousands of persons. The launching was sideways, an unusual engineering feat due to the bulk of the vessel, which is 5150 gross tons.

◆

Louisiana state authorities have prevented the construction of a 20-in. natural gas line from South Louisiana fields to Kentucky. The Tennessee Gas and Transmission Company has amended its application to build the line now before the Federal Power Commission, stating it had been unable to obtain gas from Louisiana and now planned to acquire it from near Corpus Christi, Texas.

Permission for the line had been granted by the FPC provided that the company show that it had contracted for gas supplies for the line. Louisiana state officials maintain that the state's gas supplies are being exhausted; that the Appalachian area has huge coal deposits that will serve.

◆

Oklahoma Pipe Line Company of Tulsa, Oklahoma, a subsidiary of Standard Oil Company of New Jersey, has begun construction of a gathering system in Union and Henderson counties, Kentucky, to handle production from the Hitesville, Cairo, and Robards fields and deliver it to the Owensboro-Ashland Pipe Line Company at a point near Robards, Kentucky. The Carter Oil Company, also a Standard subsidiary, is the principal producer of these fields.

◆

Waiting for the completion of a more than 600-mile pipe line from Norman Wells, Northwest Territory, to the refinery at Whitehorse, Yukon Territory, the wells being drilled in the Northern Canada pool are tested and then capped. Construction work is handled by Bechtel-Price-Callahan of Oklahoma with the United States Army Corps of Engineers supervising the job of laying pipe line over almost impassable terrain. Roads must be cut through before the pipe line crews can advance.

The pipe comes down the Mackenzie River from the head of rail at Waterways, Alberta, by barge. The 30-ft. joints of steel pipe are trucked from Canol to a pipe depot where they are welded together to make 60-ft. sections. These are then trucked to the head of the pipe line, which is now in the foothills of the Carcajou mountains, west of Canol.

THE Petroleum Engineer

SEPTEMBER, 1943

Field Study of High-Pressure Gas Sampling

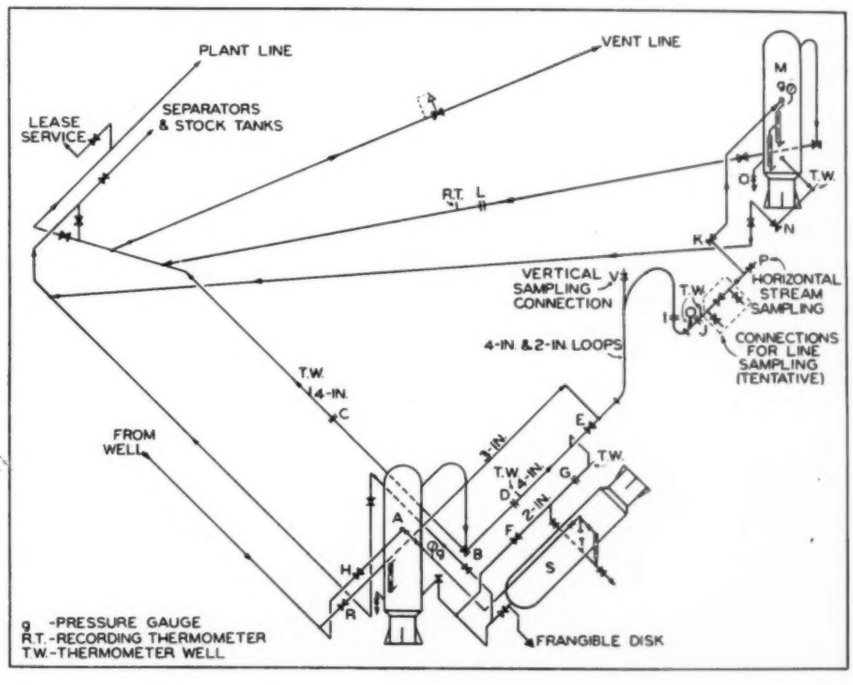
PETROLEUM ENGINEER Exclusive Feature

☆ N.G.A.A. sponsors tests in Katy gas field unit

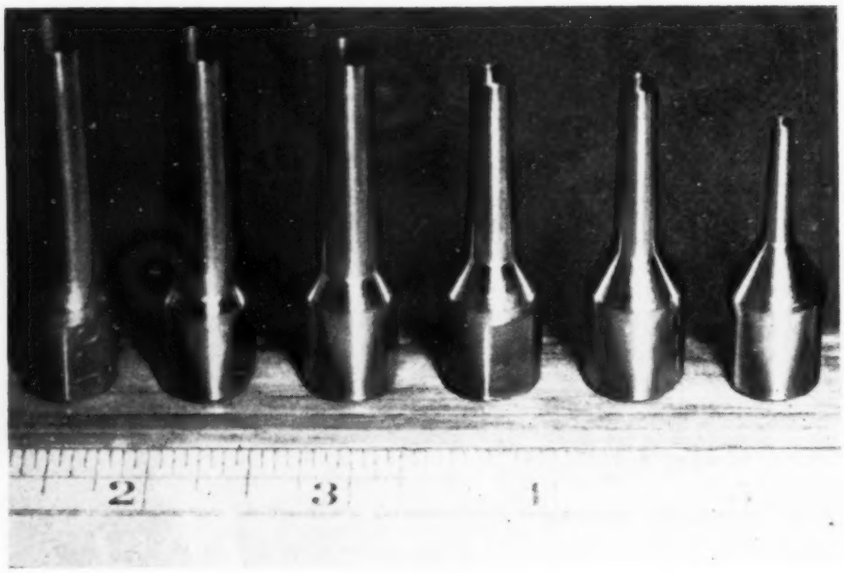
by C. C. Pryor, Associate Editor

A study of the complex problems confronting operators of high-pressure wells producing natural gas and condensate or "distillate" is now under way on a Stanolind Oil and Gas Company lease in the Katy gas field unit, Waller County, near Houston, Texas. The tests are being sponsored by the Natural Gasoline Association of America and are being conducted by Dr. G. G. Brown and Dr. D. L. Katz, University of Michigan, and their assistants, C. M. Sliepcevich and M. J. Rzasa. A large number of oil companies are participating in the project and are lending much of the high-pressure equipment to the N.G.A.A. for the tests. Additional equipment required was provided by manufacturing companies of high-pressure valves, pipe and fittings, meters, separators, chokes, etc. W. F. Lowe, N.G.A.A. secretary, is in charge of assembling equipment and other details for the tests.

N.G.A.A. president, J. W. Vaiden, Skelly Oil Company, Tulsa, Oklahoma, said the usual approach to these problems through committee work had to be set aside temporarily. The manpower shortage and transportation handicaps in these times have made usual procedure rather slow and difficult, especially field testing, when committeemen must leave their own work for



Flow diagram of the equipment as set up for the field tests



Sampling tips for the tests

weeks at a time. Accordingly, the association has sponsored a cooperative project and raised a special fund to retain competent experts to conduct the field studies. Unquestionably, the results of this work will be of great importance to the distillate industry and will be of value in all cycling, repressuring, and pressure maintenance operations.

Present Methods

At present high-pressure wells producing natural gas and condensate are sampled at the wellhead by withdrawing a small portion of the well stream. Normally, the flowing stream contains a small proportion of liquid phase at wellhead conditions. The field separators receive the entire effluent from the well and separate the gas phase from the liquid phase. Comparison of small samples taken through tubes injected into the flowing stream with the results of the commercial separator handling the entire stream indicated that proper sampling technique might provide a small stream containing the same proportion of liquid to gas phase as the total well effluent, but frequently the small sample is found to be quite different.

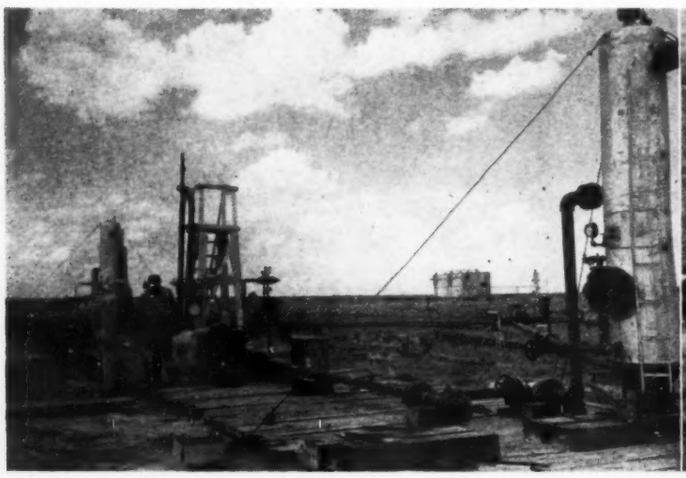
At a meeting held in Tulsa, Oklahoma, June 14, under the auspices of the N.G.A.A., it was decided that the principal objective of the tests would be a simple and practical method for sampling a two-phase gas stream. The experiments are being made with various types of equipment through a pressure range of 1000 to 2500 lb. per sq. in. on streams containing up to about 10 percent liquid phase by volume. Other experiments are to be made with new methods for determining the specific gravity and liquid content of such gases. Among the many important objectives of the project is a comparison of the readings of the vertical and horizontal meter runs on the streams under test.

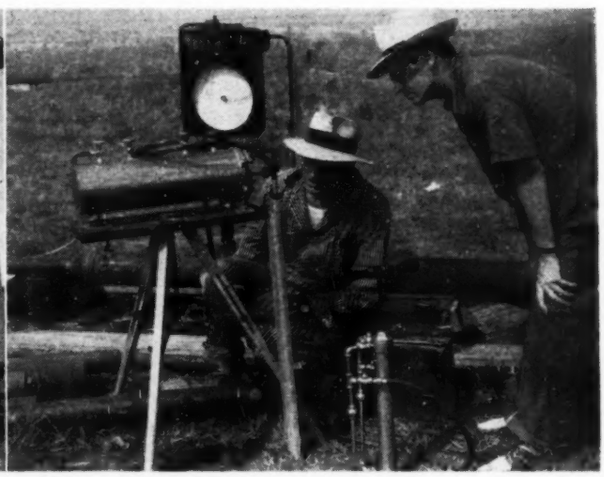
Test Equipment

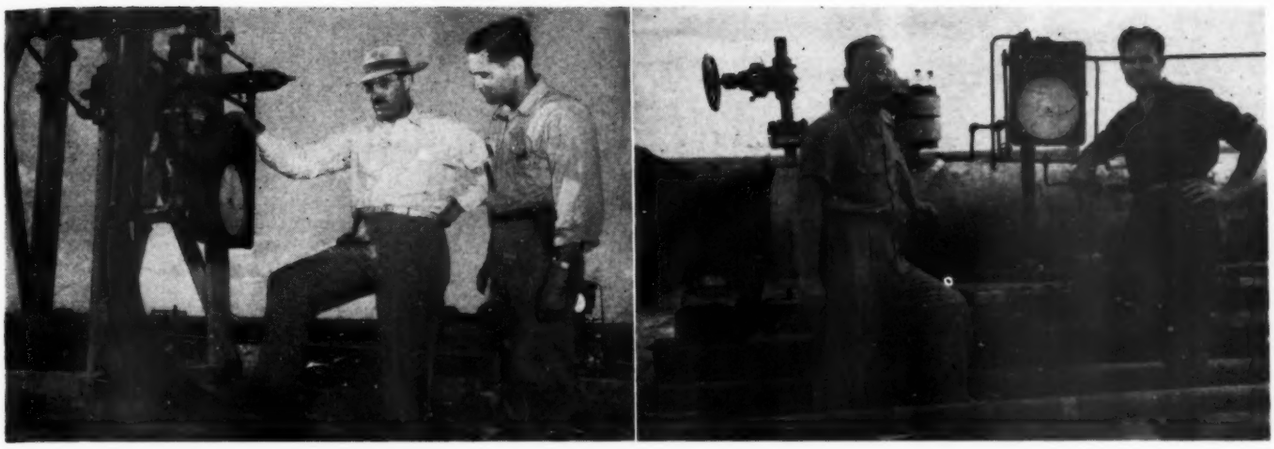
Elaborate, full scale equipment for the tests was set up at the No. 9 well of the Katy cycling unit under the immediate supervision of Carl J. Mantzel, Stanolind Oil and Gas Company. The general plan and testing layout of the project is the work of N.G.A.A. vice president, C. R. Williams, High-Pressure Gas Division, The Chicago Corporation; R. J. Sullivan, Humble Oil and Refining Company; M. R. Church, Shell Oil Company, Inc.; W. L. Bowser, Atlantic Refining Company; J. R. Butler, Cotton Valley Operators Committee, and D. A. Sillers, Lone Star Gas Company. E. O. Bennett, consulting engineer, made final inspection of the high-pressure set-up at the hydrostatic tests.

The No. 9 well in the Katy gas field unit is capable of producing 30,000,000 cu. ft. of gas containing some liquid at a wellhead pressure of 2500 lb. and is equipped for these tests as shown in the accompanying flow diagram. The adjustable choke U controls the well

Left: View of the equipment in the field. Separator M is at far right. The lubricator can be seen in the foreground of the picture. Right: J. B. Gibbs, Union Producing Company, and M. J. Rzasa, University of Michigan, set up apparatus for gas-gravity determination







Left: Dr. D. L. Katz and C. M. Sliepcevich, University of Michigan, at vertical orifice meter I. Right: D. B. Harrison, Atlantic Refining Company, and J. D. Collett, Associated Engineers, who are observing the tests for their respective companies

flow. During the testing, gas is not vented to the atmosphere, but enters a line to the Katy cycling plant, the vent being installed as a safety measure.

Test Procedure

When testing the full well stream, the valve H is closed and the fluid passes through valve R directly to a vertical sampling tube V, vertical meter run I, horizontal meter run J, horizontal sampling device P, choke K, and separator M. Gas production is measured at about 900 lb. using the orifice meter L on the separator gas. Liquid production is measured by the rate of rise of liquid in the calibrated separator. Sampling tubes V or P lead to the small scale separation unit Q in which the sample will be separated into gas and liquid at the same pressure and temperature as in M. Evidence of a representative sample will be the same liquid-gas ratio in the separator and in the equilibrium cell as based on direct comparison of volumetric measurements made at the same conditions.

Varying Liquid-gas ratio

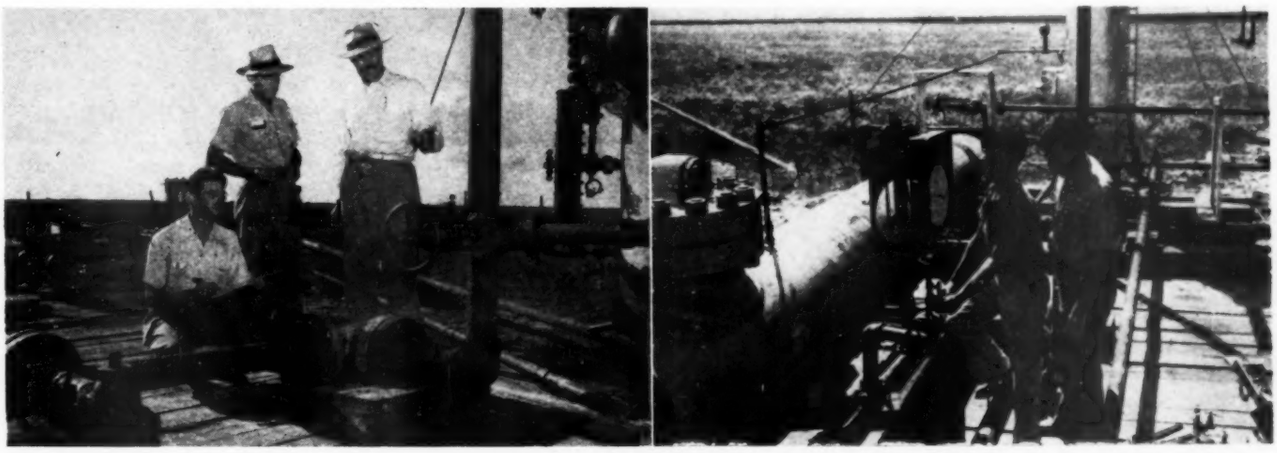
The test equipment set-up permits variations of the liquid-gas ratio at a given pressure. Valve R may be closed and valve H opened, passing the well stream to separator A. Then gas from separator A may be divided, a portion by-passing through choke valve B. The remainder, after passing meter D, is mixed with the desired quantity of liquid and passed through the sampling lines to separator M. The liquid accumulated in separator A may be measured in the calibrated section of the separator or returned continuously to the gas stream through valve F and meter G. This permits the liquid content at the sampling point to be increased in proportion to the gas by-passed. Tank S, which is a 1500-lb. separator laid on its side, will be used to accumulate hydrocarbon liquid, or filled with water, which may be displaced into the flowing gas over a limited period of time to increase further the liquid-gas ratio.

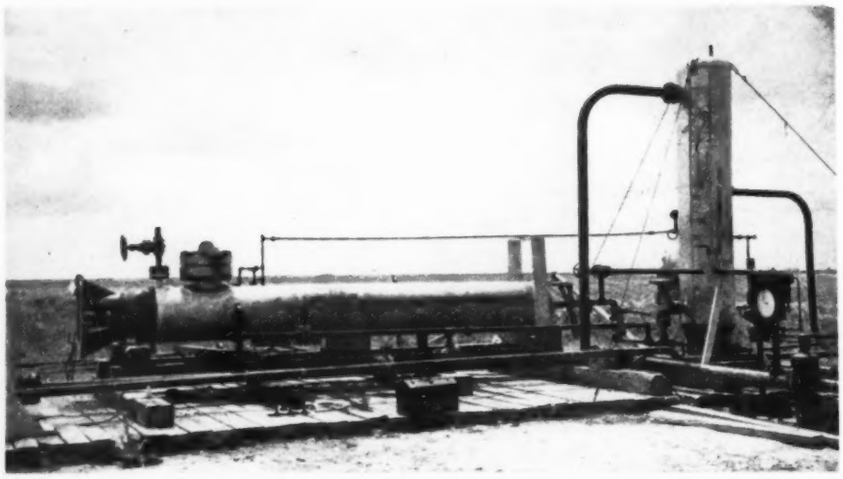
One sampling tip and one separation unit (Q) as well as the sampling tip mixing devices, and separation units of the cooperating companies and laboratories will be tested.

Vertical vs. Horizontal Samples

Studies will be conducted in both vertical and horizontal sampling arrangements of the effect of the velocity of the stream being sampled, differences in velocity between the stream in the pipe and the stream in the sampling tube and the location of the sampling tube will be studied in both vertical and horizontal sampling arrangements. Provision has been made to run tests with 4-in. sampling lines, vertical and horizontal, and 2-in. sampling lines, verti-

Left: M. J. Rzasa, W. F. Lowe, secretary of N.G.A.A., and Dr. Katz check liquid level in gauge glasses on separator M. Right: A. L. Dobbs and C. D. Gorden, gas engineer, place orifice meter G in operation after completing installation





Horizontal liquid storage tank S, separator A, and orifice meter C

cal and horizontal. These two sizes of pipe are the most widely used in the industry and the tests will permit comparison of the samples.

The gravity of the gas from the separator M and the separator of unit Q operating at about 900 lb. per sq. in. or less, may be measured with the gravity balance without danger of condensation. Data for calculation of flow rates from readings of meter L, and the meter in unit Q will be provided by these gravities. Meters I and J require the composite gravity of the two-phase stream.

Gravity Computations

Computation of the composite gravity of the well stream is made by separating the gas from the liquid in unit Q at a pressure of about 15 lb. per sq. in. gauge and determining the quantities and gravities of each. Liquid collected for a metered quantity of gas and its gravity will be taken either under separator pressure or at atmospheric pressure. Cooling of the liquid between the separator at 15 lb. and the receiver at atmospheric pressure to prevent vaporization is required in the latter procedure. The usual gravity balance will be used to determine the gravity of the gas from the separator and the composite gravity of the well stream computed from these data.

A description of specified liquefiable hydrocarbons or "content" for characterizing the richness of condensate well effluents is needed. A number of methods are under consideration and it is believed that a study of the methods will be simplified and aided by the present tests.

Consideration will be given to the use of an integrating meter or critical flow orifice for the low-pressure gas from separator Q.

Participating Companies

In addition to the companies previously mentioned, others participating and observing the tests include J. S. Abercrombie Company, Arkansas Fuel Oil Company, Carter Oil Company, Cities Service Oil Company, Continental Oil Company, Gulf Plains Corporation, Houston Oil Company, La Gloria Corporation, Lockhart Oil Company of Texas, Magnolia Petroleum Company, Ohio Oil Company, Phillips Petroleum Company, Sinclair-Prairie Oil Company, Shamrock Oil and Gas Corporation, Superior Oil Company, The Texas Company, and United Gas Pipe Line Company. A total of 38 oil companies are participating in the project.

Among the engineers observing the tests are Dr. Frank H. Dotterweich, consultant, Natural Gas and Gasoline Division, Petroleum Administration for War; Don Sillers, Lone Star Gas Company; Ron Heath, Signal Oil and Gas Company; J. R. Butler, Cotton Valley Operators Association; L. B. Wood, Phillips Petroleum Company, and many others.

Manufacturing companies contributing equipment and observing the tests include Stearns-Roger Manufacturing Company, Pittsburgh Equitable Meter Company, Moorlane Company, Wescott and Greis, Inc., Refinery Supply Company, Henderson Engineering Company, Texas Pipe Bending Company, and Halliburton Oil Well Cementing Company, who tested the equipment to 4500 lb. per sq. in. after construction was completed.

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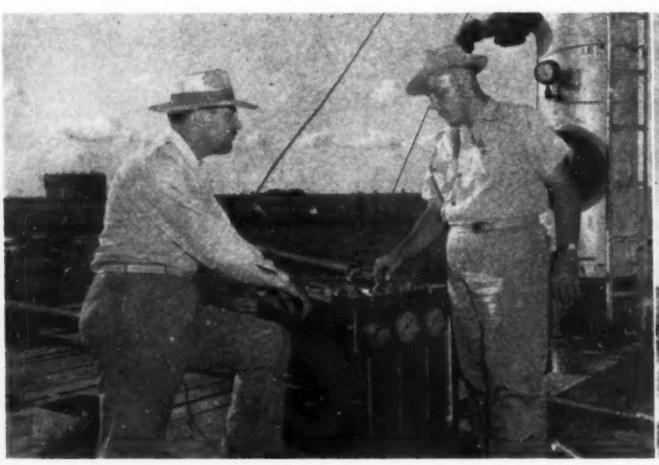
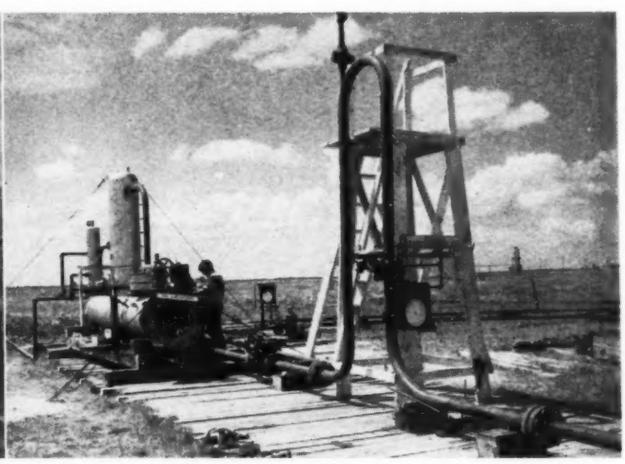
Left: Dr. Katz and Carl J. Mantzel, Stanolind Oil and Gas Company, discuss forthcoming tests, with Stanolind equilibrium cell in foreground. Left: Loop installed for vertical sampling. Fabrication of two loops permits sampling from 4-in. and 2-in. lines. Flanges simplify changing loops





The low stage of the river made it necessary to cut a channel through a sand bar and dam a part of the river to provide sufficient water for barges to operate

Permanent Repair to River Crossing Break in "Big-Inch" Line

PETROLEUM ENGINEER Exclusive

☆ **Broken by spring flood, repair is engineered to avoid similar occurrence**

by Frank H. Love

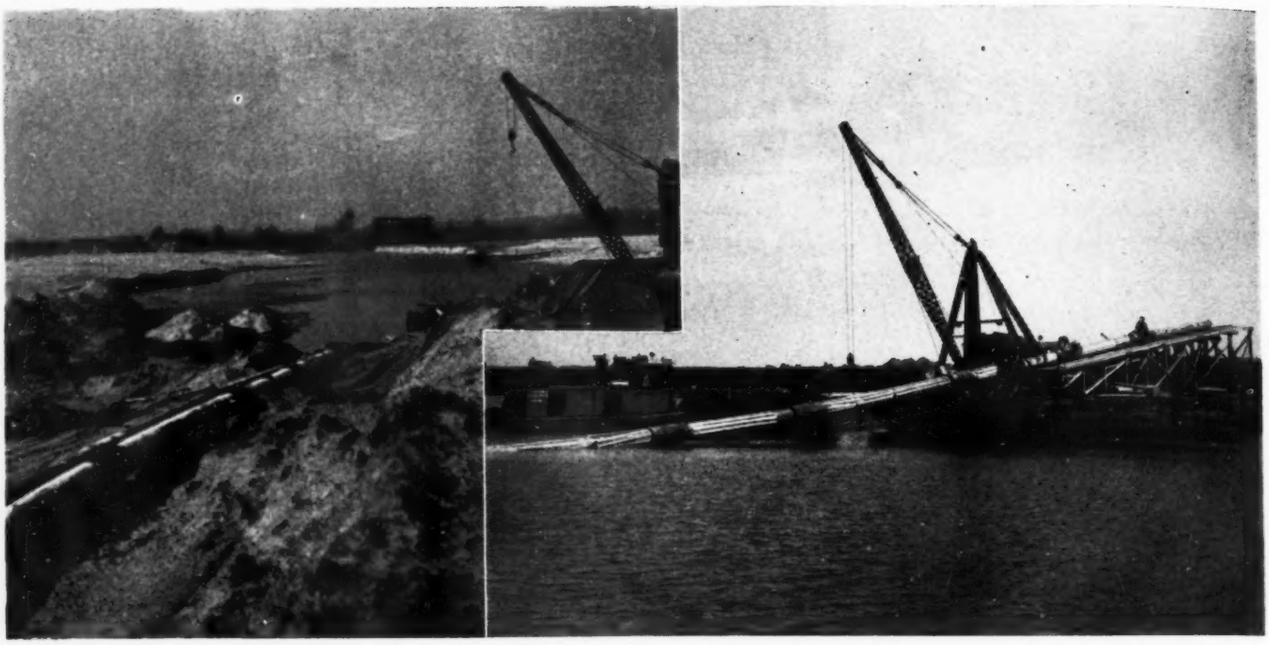
Managing Editor

PERMANENT repair has now been made to the break in the "Big-Inch" pipe line at the Arkansas River crossing, caused by the floods of last spring. At the time of the break it was impossible to make other than a temporary repair due to the extent of the flood, which caused the river to overflow its banks and inundate the neighboring countryside. The line broke when the river reached a level of 29 ft.; subsequently the crest became 30 ft. To make a temporary repair, the 24-in. line was cut near the gate valves on both sides of the river and a by-pass laid of 20-in. pipe. This size pipe was used rather than 24-in. as it was readily available due to the fact that the War Emergency Pipelines' products line was being laid in the vicinity at the time. The 20-in. by-pass was carried down one side of the river, across a railroad trestle, and back the other side where it was tied into the 24-in. line. By adopting this procedure valuable time was saved and the line was in operation within seven days.

As soon as the water receded sufficiently, work began on the permanent crossing, laid of 24-in. pipe. It was not until then that the exact nature of, or the cause for, the break could be determined. At this particular point the course of the Arkansas River shifts frequently and it was found that the current had cut into the north bank for a distance of about 1000 ft., undermining the pipe line and leaving it without support. To the weight of the pipe itself was added the weight of many large trees, which were toppled when the bank gave way, resulting in the pipe being broken in two places and badly battered in others. The two breaks were almost completely through the pipe; in fact, when the pipe was lifted the strain was sufficient to finish severing it.

Steps have now been taken to prevent a future shift in the river's course from causing a similar break. The north bank, where the break occurred, has been cut back with dragline and dredging equipment for a distance of 2000 ft. on a level with the river bottom. The same procedure has been followed for a distance of 500 ft. on the south bank. Throughout the total distance of the crossing, which including approaches is 6500 ft., the line has been buried 18 ft. below river bottom level. Officials of War Emergency Pipelines and Williams Brothers believe this will amply care for any shift in the course of the river without damage to the line.

Due to the shallowness of the river, in sharp contrast to the flooded condition that existed at the time the line broke, it was necessary to cut a channel 200 ft. wide through a sand bar from



Left: The approach to the river from the north bank. Right: The river crossing was laid from a barge.

the north side and dam the flow of the river from the west to provide enough water for barges to operate.

The crossing was laid from barges. On shore the pipe was triple coated and wrapped by hand, two joints then being welded together into an 80-ft. length. These lengths were loaded onto a barge equipped with a crane, which barge was towed into the river and made fast alongside the laying barge. By means of the crane the 80-ft. lengths of pipe were hoisted onto a ramp on the laying barge built at an angle of about 30 deg. The ends of the pipe were lined up by clamp in the same manner as when "stove-piping," and the welds made. All welds were reinforced with sleeves. Over these sleeves coating and wrapper were applied. Two-ton river clamps were used every 30 ft. and slats were wired to the pipe to prevent damage to coating, after which the pipe was lowered. By pulling the barge forward the pipe was allowed to slide gently off the ramp into the river, the end of course being secured to the barge. Another length of pipe was then hoisted onto the ramp and the procedure repeated.

Before laying the pipe a partial trench was made with a 14-in. hydraulic dredge. After the line was in this trench the same dredge was used to remove sand and silt from beneath the pipe and lower it to the required depth of 18 ft. below river bottom.

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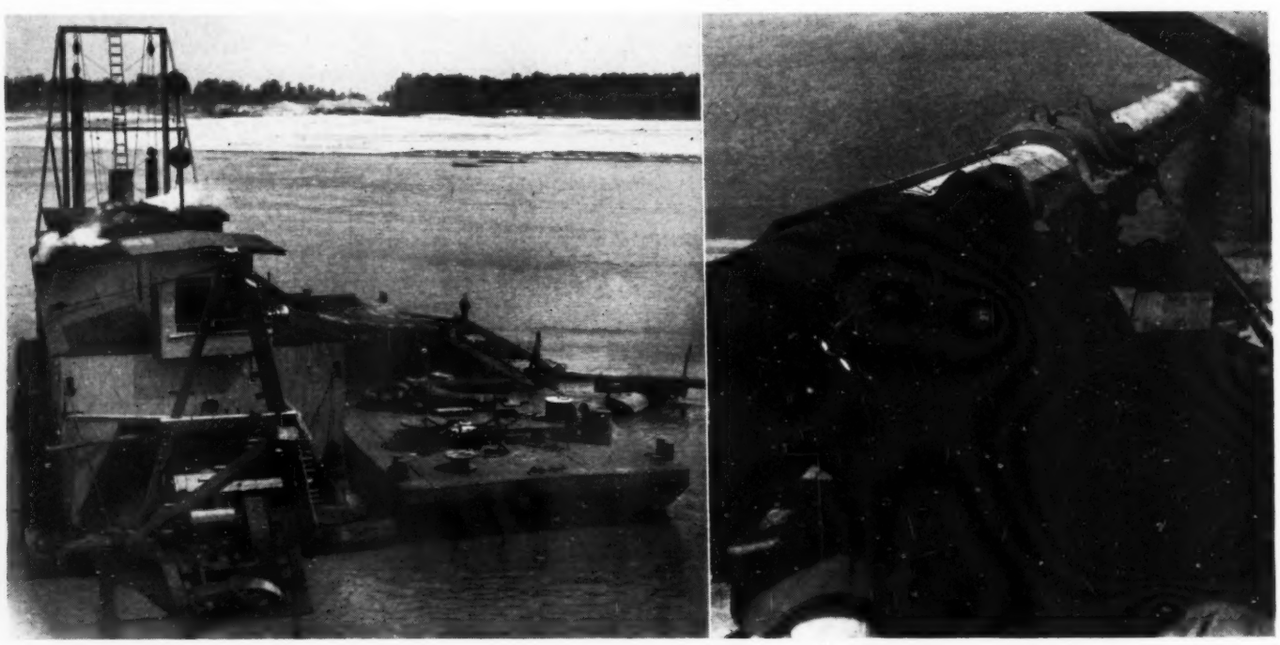
Dredging equipment used to deepen the river after the bank had been cut back (left). At the right, a welder working off the laying barge



Water Purification by the Ion-Exchange Method

PETROLEUM ENGINEER Exclusive Feature

☆ Results of observations and investigations of new materials for purpose of power plant operation

by O. K. Smith, Chemical Engineer,
United Light and Power Service Company

IN THE last few years considerable progress has been made in the field of ion-exchange water purifying materials. This development has been observed with increasing interest, and recently an investigation was made of some of these new materials from the standpoint of power plant operation.

In order that the reader may obtain a better understanding of the reason for development of these new ion-exchange softening materials, attention should be given to present methods and some of their limitations.

One of the oldest methods, and the one still most universally used, is the lime and soda process. This process gives the maximum reduction in solids, and will precipitate out of solution all carbonic acid. It does, however, leave from 15 to 20 p.p.m. of calcium carbonate in the effluent due to its natural solubility in water, and which must be precipitated in the boilers with phosphate to eliminate scale formation.

A later development was the zeolite softeners known as base exchangers. This system when carefully operated will remove all calcium and magnesium, which are the scale forming elements, and substitute a sodium ion. It does not, however, reduce the total solids, and allows the carbonic acid to remain in the effluent combined as the unstable sodium bicarbonate. Water treated in this manner, when reaching the boiler as make-up, releases the carbonic dioxide (CO_2 gas), which passes on with the steam, later combining with the condensate to form carbonic acid, which will increase corrosion possibilities. The sodium ion therefore remains in the boiler water and will build up a high concentration of caustic alkalinity unless excessive blowdown is employed.

These new developments in ion-exchange materials are designed to overcome the undesirable features in the older type softeners and obviate the need for evaporators.

As stated, the zeolite materials exchanged sodium for calcium and magnesium, the scale forming elements. As sodium is also a positive or cation, it

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for the last 21 years has been a chemical engineer for the United Light and Power Service Company, Davenport, Iowa, in charge of laboratories and development work—During the first World War he was one of the superintendents in charge of diphenylamine production at the government's smokeless powder plant at Nashville, Tennessee, and for two years subsequent to the close of the war he was with the Western States Portland Cement Company, Engineering Department, Independence, Kansas.

was reasoned that sodium could be removed as well as calcium, magnesium, and iron; also, that the replaceable ion should be hydrogen. Work along this line later revealed the fact that "carbonaceous" materials such as wood, coal, peat, lignite, etc., if properly prepared could be made into softening materials. When treated with fuming sulphuric acid, chlorosulphuric acid, etc., the "hydrogen zeolite" is produced and will remove all positive ions including the sodium. Likewise, if treated with sodium chloride, it then only removes the calcium and magnesium, transferring the sodium ion to the effluent the same as the original zeolites.

Synthetic Resins

In 1935 Adams and Holmes discovered that certain synthetic resins possessed ion-exchange characteristics. Of these the condensation products of polyhydric phenols with formaldehyde, aniline or m-phenylene diamine with an aldehyde, or tannins with formaldehyde, are the materials giving best results. These perform very much the same as the carbonaceous materials, and both have higher capacities and are less fragile than the former type of silicious zeolites.

Up to this point, only the positive ions have been removed. After the hydrogen exchangers had been worked out, and the sodium ion was also removed, the negative or acid ions remained in the effluent. The sulphates produced sulphuric acid, the chlorides hydrochloric acid, the nitrates nitric acid, and the bicarbonates carbonic acid.

It was reasoned further that if the positive or cations could be removed by the exchange process, the negative or anions could also be removed in the same manner. The natural course of procedure was to treat the material with an alkali such as caustic soda or sodium carbonate to produce an exchange element for the negative ion. This procedure was found to be correct, and we thus have a process that theoretically will remove all solids from the water at normal temperatures, and should be equal to distilled or evaporator water.

The development of these new exchange materials has produced much flexibility in purification methods. The one that is perhaps the most intriguing is the complete demineralizing method. In this the water is reduced to almost the equivalent of laboratory distilled water. It is accomplished in two steps, the first removing all positive ions, whereas the second step removes the negative ions with exception of the carbonic acid. Strangely enough the CO_2 is not adsorbed by any of these materials and must be eliminated by aeration. This produces an effluent with a pH value of about 6.8, and becomes quite an aggressive water with respect to corrosion in the system. It is therefore necessary to add enough alkalinity to the final effluent to raise the pH value to about 8.5 in order to eliminate cor-

rosion in the pipe lines, and eventually produce a pH value of about 11.0 in the boiler water. Silica is not removed by this method, and if this should be a disturbing factor in a process it must be removed from the water before entering the exchange equipment.

Hydrogen Exchangers

Another, and perhaps the most popular method to date, is a combination of the positive ion or "hydrogen exchangers" and the former zeolite process. The latter is usually made up of the new carbonaceous or resinous materials, and are regenerated with sodium chloride as formerly. As stated, effluent from the hydrogen exchanger contains mineral acids in proportion to their corresponding salts in the raw water. The proportion of water therefore put through the sodium exchangers is just sufficient to neutralize the acids from the hydrogen exchangers. A modification of this method is also possible in that the sodium exchanger can be eliminated and the acids from the hydrogen exchanger simply neutralized by the addition of caustic soda. In this case, however, the cost of sodium hydroxide is approximately four times that of sodium chloride used in regenerating the sodium exchanger, and therefore this method is economically possible only when the sulphates and chlorides are low in the raw water. No doubt the latest innovation in this type of softening is to use a single unit and regenerate with a combination of sodium chloride and sulphuric acid. In this way both replaceable sodium and hydrogen ions are present and the final results are the same as with the combination units. The proportion of sulphuric acid to sodium chloride in the regenerative fluid is regulated to give about 1½ grains of alkalinity in the final effluent.

Perhaps the greatest improvements in the physical characteristics of these exchange materials over some of the former synthetic silicious zeolites are their increased capacities and durability. Smaller equipment and less floor space for the same capacity is not only an economic factor but quite often an advantage in installing the equipment.

Synthetic resin materials known as "The Amberlites" are being marketed by The Resinous Products Chemical Company of Philadelphia, Pennsylvania. Its Amberlite IR-1 is for removal of the cations, and its Amberlite IR-4 is for removal of the anions.

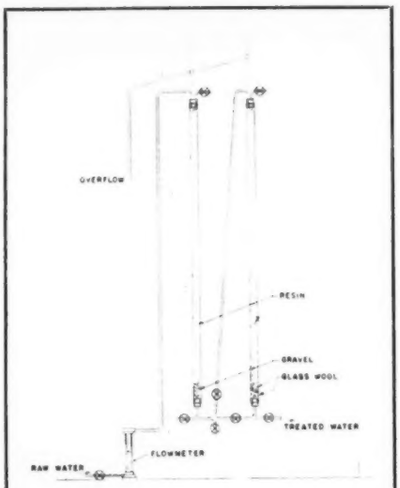


Fig. 1. Apparatus used to test Amberlite resins

Laboratory Tests

The apparatus set up to test the Amberlite resins is shown in Fig. 1. The tubes for holding the resins were 4 ft. long and 0.9 in. in diameter. The tubes were calibrated in units of 10 ml. so that the volume of resin could be easily determined. Enough IR-1 resin was added to the first tube and IR-4 resin to the second tube to give a "back washed and drained volume" of 240 ml.

The following solutions were prepared in 5 gal. bottles for regeneration:

1. 4 percent hydrochloric acid
2. 4 percent sodium carbonate
3. 2 percent sulphuric acid
4. Distilled water

A flowmeter was constructed, of the Rotameter type, as shown in Fig. 2, the taper tube being made of clear plastic. The flowmeter was calibrated to read in terms of "gallons per minute per square foot of bed area."

Raw water supply was Davenport city water drawn from a 20-gal. storage tank suspended near the ceiling.

The following method of operation was used:

For Amberlite IR-1

1. Backwash the column bed in place with distilled water to give 50 percent bed expansion. Allow to settle and drain at the rate of 5 gal. per sq. ft. per min. Drain down to within 1 in. of bed.

2. Regenerate by passing 4 percent acid solution down flow through the bed at 2 gal. rate. Use the equivalent of 11 gal. per cu. ft. of bed volume.

3. Rinse by passing distilled water down flow at 2 gal. rate until 7.5 gal. per cu. ft. of bed volume have been collected, then increase to 5 gal. rate until effluent is free of chloride.

4. Backwash with distilled water to give a 50 percent bed expansion and collect 6 gal. per cu. ft. of bed volume. Allow to settle, then drain to 1 in. of top of bed.

5. Operate by passing raw water from supply tank down flow through bed at 5 gal. rate. Sample each liter and discontinue when soap test shows first sign of calcium present.

For Amberlite IR-4

1. Backwash with distilled water to 30 to 50 percent bed expansion, then drain to 1 in. of top of bed.

2. Regenerate by passing 4 percent

TABLE I

Capacity tests on Amberlite resins (H = hardness)

Liters of water through both columns	Cycle 1			Cycle 2			Cycle 3			Cycle 4			Cycle 5		
	IR-1 pH	IR-4 pH	H	IR-1 pH	IR-4 pH	H	IR-1 pH	IR-4 pH	H	IR-1 pH	IR-4 pH	H	IR-1 pH	IR-4 pH	H
1	3.00	8.34	10												
2		7.20	8			9	3.05	5.19	8		4.98	8		5.56	6
3	3.04	7.46	6	2.88	5.39	7		5.03	6	3.13	4.85	6		4.85	6
4	2.96	7.65	4	2.88	5.28	8	3.14	5.02	4		4.69	6	3.15	4.92	4
5	3.06	7.41	4	2.85				4.92	6		4.64	4		4.80	4
6	3.14	7.48	8	2.85	5.65	8	3.14	4.93	6		4.53	4		4.80	4
7	3.01	7.70	0	2.84	5.19	6		4.90	6		4.47	4		4.77	4
8	3.02	7.07	0	3.07	5.42	7		4.88	4		4.46	4		4.75	4
9	3.22	7.18	0	2.92	7.83	9		4.77	6		4.43	4		4.72	4
10	3.13	7.20	0	2.92	5.37	8	3.13	4.91	4		4.40	4			
11	3.21	6.39	0	2.93	5.33	6		4.85	4		4.43	4		4.72	4
12	3.14	6.09	0					4.91	4		4.40	4		4.79	4
13	3.11	5.80	0			8		4.85	4		4.45	4			
14	3.05	5.67	0			8		4.87	4		4.45	4		4.77	4
15	3.01	5.66	0			7	3.14	4.90	4		4.45	4			
16			0			7			6		4.58	4		4.77	4
17			0					4.85	10		4.55	4			
18	2.93	8.08	20					4.85	8		4.58	4		4.81	4
19	2.98	6.33	0					4.89	6		4.58	4			
20	2.96	6.03	0			8		4.87	6					4.70	4
21	2.95	5.73	0	2.92	5.13			4.85	6		4.53	4			
22	2.95	5.64	4		6.02	14		4.87	6		4.53	4		5.00	4
23	2.96	5.45	6			10		4.82	4		4.54	4		4.93	4
24	2.90	5.50	6			10		4.86	6		4.62	4		4.78	4
25	2.90	6.00	6			10	3.13	4.86	4		4.68	6		4.87	4
26	2.93	5.49	6					4.86	6		4.65	4			
27	2.89	5.54	6			8		4.82	4		4.58	4		4.87	4
28	2.96	5.73	4					4.82	6		4.62	4		4.84	4
29	2.98	5.92	6			7		4.82	6		4.67	4			
30	3.11	6.07	8			10		4.87	6		4.67	4			
31	3.20	6.20	12					4.82	6		4.67	4			
32	3.32	6.28	16		5.88	8	3.11	4.83	6		4.67	4			
33	4.64	6.44	24			10		4.85	6		4.77	4			
34	5.90	6.48	36					4.92	4		4.91	4			
35								5.04	4		5.08	4			
36				4.80	6.17	21		5.25	4		5.29	4			
37						25		5.50	4		5.46	4			
38								5.80	2		5.95	8			
39								5.83	4		5.88	4			
40								6.05	4		5.97	6			
41								6.17	9		6.19	10			
42								6.33	14	5.41	6.33	14			

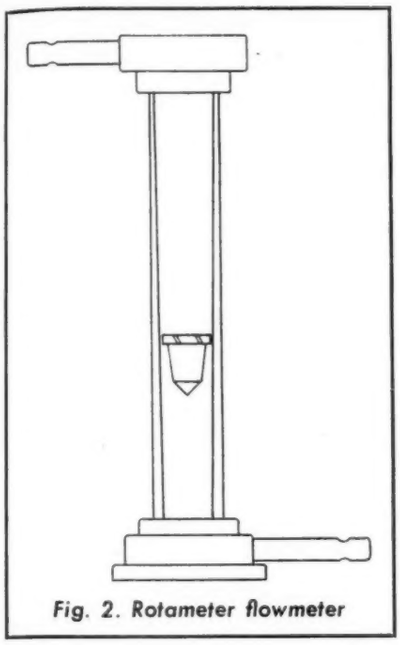


Fig. 2. Rotameter flowmeter

sodium carbonate solution down flow at 1.5 gal. rate until the equivalent of 35 gal. per cu. ft. of bed volume have been collected.

3. Rinse by passing distilled water down flow at 5 gal. rate until neutral to phenolphthalein indicator.

4. Backwash as described above.

5. Operate by passing effluent from first column down flow at 5 gal. rate. Sample each liter and discontinue when soap test shows first sign of increase in hardness.

The results of several tests on the Amberlite resins are shown in Table 1. The first column gives the pH of the effluent from the IR-1 tube, and the second and third columns give the pH and hardness of the effluent from the IR-4 tube.

The Permutit Zeo-Karb H and DeAcidite were tested in the same way except that the DeAcidite was regenerated with 2 percent sulphuric acid. The results of the second cycle are shown in Table 2. This cycle was not run to completion.

A small amount of soap indicated "hardness" remains in the water treated in this manner. Repeated tests showed no calcium or magnesium present and the low pH of about 5.0 indicates that this hardness is due to mineral acids. This hardness, of course, is not scale forming. The amount of caustic necessary to neutralize traces of acids, and to raise the alkalinity of the treated water to various pH values is shown in Fig. 3. In running cycle No. 6, the final effluent was aerated to remove the free carbonic acid before adding caustic to raise the alkalinity. It will be noted from Fig. 3 that the amount of caustic soda in lb. per 1000 gal. necessary to neutralize this excess carbon dioxide acidity is quite small. We believe it would always be advisable, however, to aerate the IR-4 and DeAcidite effluents before raising the alkalinity, in order to eliminate this CO_2 from the condensate in the operating cycle.

In making these tests Davenport city water was used, analysis of which is shown in Table 3. Analyses were also made of the effluent from the Amberlite IR-1 and IR-4 after the first four cycles.

Results of the tests on both kinds of material compare favorably with the published data of both companies. There was a small amount of fine material washed out of each purifier in the beginning, but after this was once removed, no more was washed out during the regeneration periods. This point was watched especially due to the fact that some of the former synthetic zeolites were somewhat fragile, resulting in a certain amount of spawling and loss of material during operation. All four materials, however, seem to be quite rugged and not so susceptible to spawling on expansion and contraction.

In the laboratory tests it was possible to get approximately the same depth of bed as in a commercial installation, but of course a very small area in cross-section. During the regeneration periods difficulty was experienced in getting the material to break up in order to get the wash water through it. The whole mass would simply rise to the upper part of tube and it was then necessary to break it up mechanically. It is believed, however, that this was due to the narrow cross-section of the equipment, and would not occur in a large installation.

Fig. 3. Sodium hydroxide required to bring water treated with Amberlite to a pH of 11.0

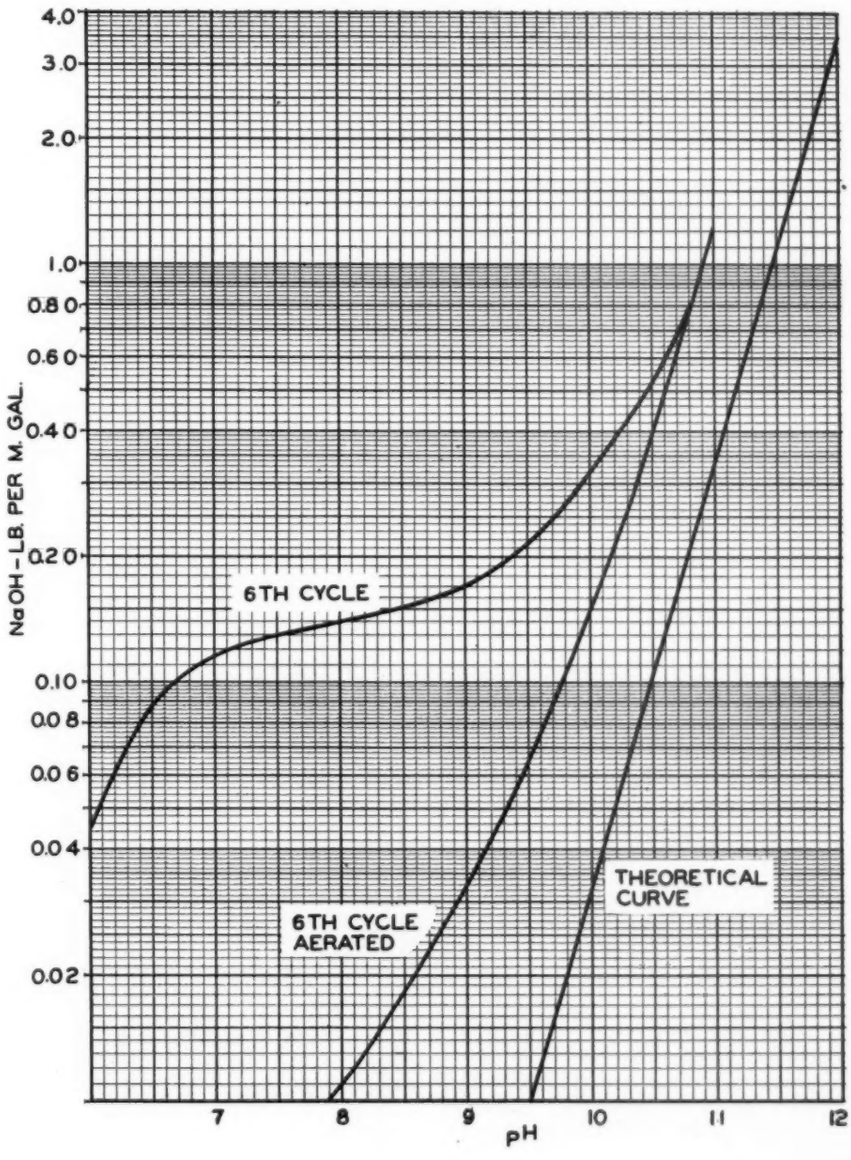


TABLE 2

Capacity test on Permutit Carbonaceous Zeolite—Second cycle

Liters of water through both columns	Zeo-Carb-H pH	De-Acidite pH	H
1			
2			6
3			6
4			6
5			6
6	2.95	5.77	8
7		5.67	6
8		5.52	6
9		5.40	8
10		5.31	6
11	2.94	5.46	6
12		5.28	6
13		5.20	6
14		5.24	6
15		5.24	
16		5.27	
17	2.99	5.32	6
18		5.16	6
19		5.21	6
20		5.16	6
21		5.16	6
22		5.16	6
23		5.16	
24		5.19	
25		5.19	
26		5.19	
27		5.19	
28		5.22	
29		5.22	
30	2.99	5.32	
31		5.17	
32		5.20	
33			
34		5.20	
35		5.20	
36		5.22	
37		5.20	
38		5.20	
39	2.99	5.25	
40		5.22	
41		5.25	6

TABLE 3

Water analysis

Raw water treated with Amberlite resins	p.p.m.	Gr./gal.
SiO_3	7	0.41
$Ca(HCO_3)_2$	190	11.08
$Mg(HCO_3)_2$	31	1.81
$MgSO_4$	54	3.15
NA_2SO_4	4	0.23
NACL	16	0.93
Hardness as $CACO_3$ — 178 p.p.m.		

Raw water treated with Permutit Carbonaceous Zeolites	p.p.m.	Gr./gal.
SiO_2	3	0.18
$Ca(HCO_3)_2$	154	8.99
$CaSO_4$	7	0.41
$MgSO_4$	55	3.21
NACL	8	0.47
Hardness as $CACO_3$—146 p.p.m.		

Analysis of water after passing through Amberlite IR-1 and IR-4

	1st cycle p.p.m.	2nd cycle p.p.m.	3rd cycle p.p.m.	4th cycle p.p.m.
Total solids	18.8	15.6	12.6	12.3
Soluble solids	12.0	7.8	8.2	7.0
Organic	6.8	7.8	4.4	5.3
SiO_3			6.7	6.2
FE_2O_3			Trace	
CA			None	

Grains hardness (as $CACO_3$) removed per cu. ft. of bed

Amberlite resins	
First cycle	9,306
Second cycle	11,700
Third cycle	13,000
Fo rth cycle	12,460
Fifth cycle	9,600

Permutit	
Second cycle	14,750

These tests in general appear quite favorable, yet with all new materials and processes there are usually some operating difficulties to be overcome. Due to the fact that the effluent from the cation exchangers is strongly acidic, there is certain to be more or less difficulty in getting the right kind of equipment to eliminate rapid deterioration of tanks and pipe lines. The published data to date indicate that rubber, lead, and bituminous coatings have so far been used for linings, and these of course increase the cost of equipment.

About 20 to 25 years ago evaporators were coming into more general use in power plants. In the beginning these made a vast improvement in boiler water conditioning. Corrosion difficulties soon developed, however, due to dissolved gases passing with the effluent into the system. This was due to carbon dioxide gas (CO_2) and oxygen, and these were later removed by chemical treatment for CO_2, or deaeration, which removed the CO_2 as well as the oxygen. As boiler designs have been improved with the resultant higher capacities and efficiencies, the general trend has been to a policy of treating all water before it goes to the evaporators. In using the latter equipment now to remove the solids, and using medium pressure steam, there is some loss in efficiency. This was not so pronounced when steam air preheaters were being used, but since these have been largely eliminated it is impossbile to condense all steam from the evaporators and yet use all bleeder steam that it is economically possible to use. For this reason a softener of this kind, if free from difficulties and able to produce zero solids make-up for boiler feed water without the use of heat, will no doubt better fit itself into modern methods of operation.

These new methods of water purification hold great promise for the future. The fact that complete demineralization can be accomplished without a remaining neutral salt opens up great possibilities for use in chemical, power, beverage, ice, and dye plants, as well as numerous other industries.

☆ ☆ ☆

Steel Pipe and Tube Specifications Established by War Production Board

Standard specifications for steel pressure pipe, steel pressure tubes, and other types of steel pipe were established August 30 by the War Production Board in order to obtain maximum production from existing facilities.

The specifications, embodied in Schedules 11, 12, and 13 to Limitation Order L-211, are part of the War Production Board program to reduce the number of types and sizes of various steel products.

Schedule 11 provides specifications and standard sizes for steel pressure pipe commonly used in power plants and certain industrial plants. The specifications cover both carbon and alloy steel piping in lap welded, seamless, electric resistance welded, and fusion welded grades. A large portion of current production is already in substantial agreement with the provisions of the schedule.

Schedule 12, covering steel pressure tubes, includes boiler, cracking still, heat exchanger, condenser, and superheater tubes. They are especially important for oil, synthetic rubber, and chemical production.

Schedule 13 sets up specifications for steel pipe, exclusive of pipe covered by other schedules, and certain specialty items such as corrugated pipe, dredge pipe, etc. The schedule will require a reduction of about 65 percent in the number of sizes and wall thicknesses shown in various pipe mill catalogs.

Drilling Fitzgerald and Vizard Unit Well No. 1

World's Deepest Producer Completed in Louisiana

PETROLEUM ENGINEER Exclusive Feature

☆ Union Producing Company, Fohs Oil Company drill gas well to 13,560 ft.—Production from 13,475-490 ft.

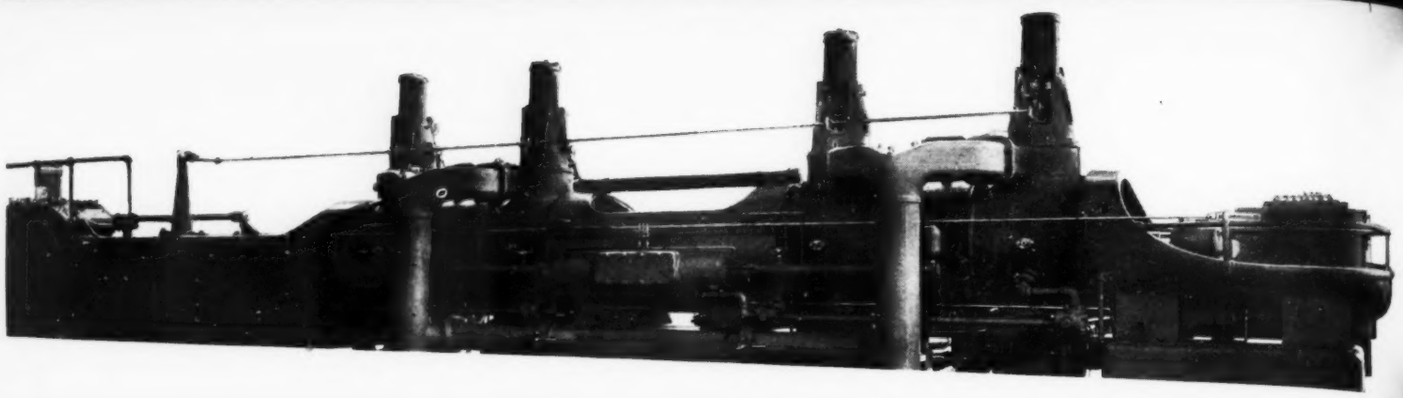
by C. C. Pryor
Associate Editor

THE well, Fitzgerald and Vizard Unit No. 1, DeLarge field, Terrebonne Parish, Louisiana, drilled by the Union Producing Company, Fohs Oil Company, et al, is believed to be the deepest producing gas well in the world. Drilled to a total depth of 13,560 ft., the well produces from perforations between 13,475 and 13,490 ft., exceeding the former 13,256 ft. production record depth of the Buckley-Bourg No. 1 well drilled in 1938. Deepest well in the world is the KCL-A2, Kearn County, California, drilled to 15,004 ft. in 1938. However, this well produces from the shallower plugged-back depth of 13,170 ft.

Gas production from the new well will be utilized in the Lirette-Mobile pipe line, which serves industries and communities along the Gulf Coast to Mobile and Pensacola. The additional gas is needed to meet the increasing demands of war industries and growing communities in these areas. Estimated production of the well is 5,970,000 cu. ft. per day on a ¼ in. choke at a pressure of 4300 lb. Rock pressure of the well is estimated at 4500 lb.

Location of the well is in the southwest corner of section 77-19s-17e in the Louisiana marshlands and is reached by means of a canal dredged for the purpose about 4.5 miles in length. A drilling barge was towed to location and used to drill the well. It was owned by Loffland Brothers Drilling Company of Tulsa, Oklahoma, and is of the double submersible type. The unit consisted of the drilling barges, water and fuel barge, and the barge used to transport

(Continued on Page 64)



NO PRIORITIES

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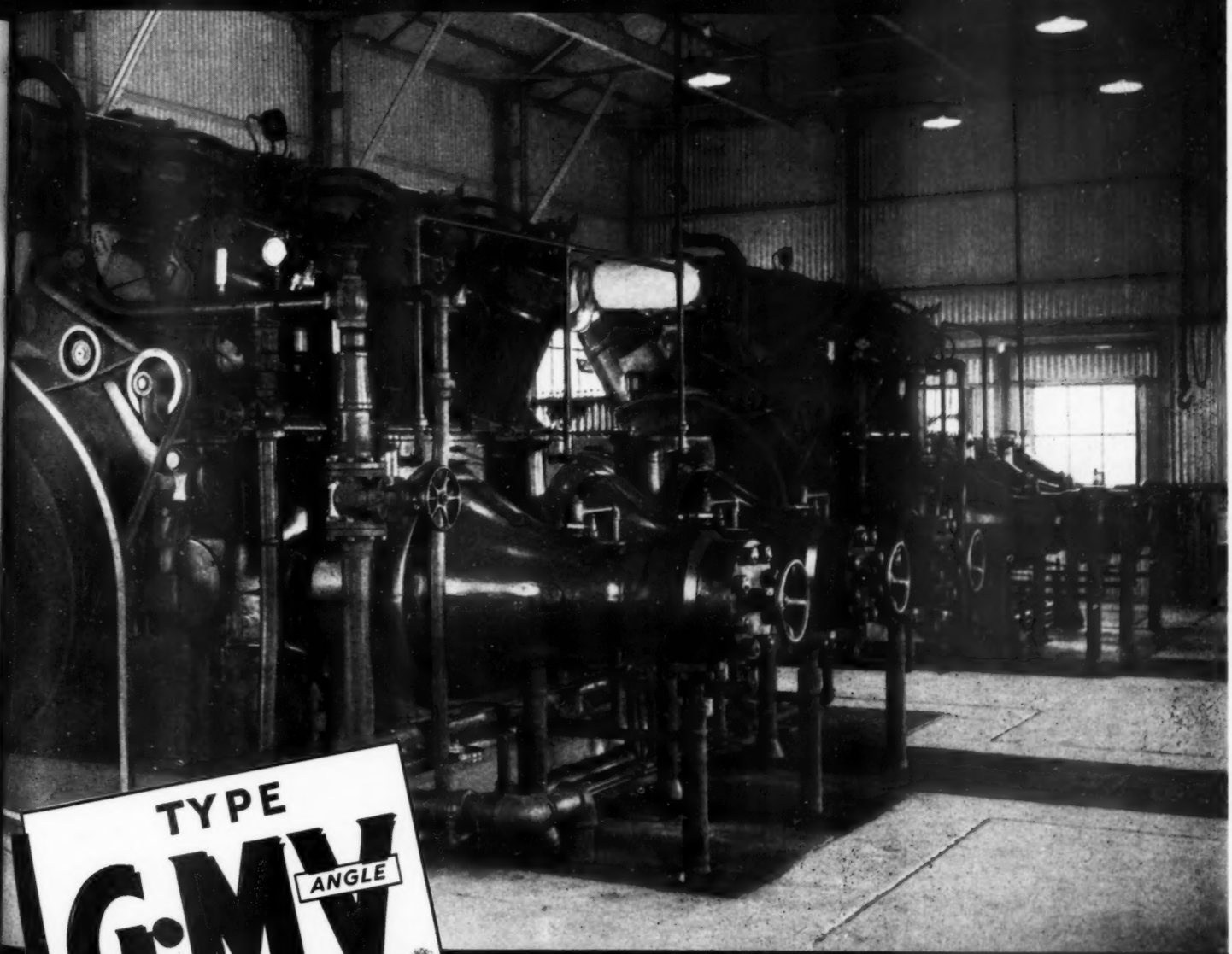

TYPE G-MV ANGLE

Compressor

New York Washington Bradford, Pa. Parkersburg, W. Va. Gloucester, Mass.

MUD RECORDS

Depth, ft.	Type of mud	Weight, lb.
0-9900	Began drilling with mud built up with clay, Aquagel, and 25 sacks Baroid. No additional weighting material used to 9900 ft. Started treatment to control viscosity at 8200 ft.	9.6 to 10.1
9900-10,900	Started weighting mud with Baroid at 9900 ft. Added Aquagel and treated to control viscosity.	10.1 to 10.6
10,900-11,500	Baroid mud with Aquagel. Treated to control viscosity.	10.6
11,500-12,100	Baroid mud with Aquagel. Treated to control viscosity.	10.6 to 11.0
12,100-12,400	Baroid mud with Aquagel. Treated to control viscosity.	11.0
12,400-13,000	Baroid mud with Aquagel. Treated to control viscosity.	11.0 to 12.1
13,000-13,560 total depth	Baroid mud with Aquagel. Treated to control viscosity.	12.1 to 12.3

MUD MATERIALS

Mud	No. sacks	Mud	Weight, lb.
		Stabilite No. 8	3740
Aquagel	1250	Quadrafos	5 0
Baroid	7000	Quebracho	15,200
Xact-clay	773	Caustic soda	1300
Conrad clay	75	Phosphate No. 48	9
Lime	2	Phosphate No. 99	10

(Continued from Page 61)

pipe and other necessary equipment.

A second unusual feature of the well in addition to its deep production record is the main string of casing. A total of 11,461 ft. of 9⅝ in. casing was run and cemented with 1500 sacks of cement. The casing weighed 53.50 lb. Other casing strings used are as follows: 60 ft. of 24 in. O.D. cemented with 35 sacks and 308 ft. of 18⅝ in. O.D., 84.50 lb., plain end, beveled for welding, cemented with 375 sacks. The 13⅜ in. O.D. casing string consisted of 279 ft. of 61.00 lb. and 2752 ft. of 54.50 lb. totaling 3021 ft. This string was cemented with 1675 sacks of cement. Total length of the 5½ in. liner was 2703 ft. The section on the bottom was 1662 ft. of 20 lb. and the top section 1041 ft. of 17 lb. pipe. Five-hundred sacks of cement were used. A slip-type hanger and a canvas packer were used to set the liner in the 9⅝ in. casing. Final liner perforations for production totaled 30 shots—2 shots per ft.

Tubing for the well consisted of 10,809 ft. of 3½ in. O.D. 9.3 lb. and 2645 ft. of 2⅞ in. 6.5 lb. O.D. pipe. A 5½ in. by 2⅞ in. packer was set at 13,462 ft.

Coring

Coring of the well was begun at 10,870 ft. However, the first signs of gas sands were found by cores beginning at 13,464½ ft. An 8 ft. core taken from 13,477 to 13,485 ft., showed a firm, clean, medium grain, gray sand, good porosity, very good gas odor and taste, and no ether cut. The same type of core was taken from 13,485 to 13,493 ft., defining the productive zone as between 13,475 to 13,490 ft. The well was cored to the total depth of 13,560 ft.

DRILLING BIT RECORD

No. bits	Type	Size, in.	Depth run, ft.
1	2-way drag	28	0-60
1	2-way drag	22	50-310
3	2-way drag	12¼	310-3312
1	pilot	17½	310-3100
11	2-way drag	12¼	3312-8786
1	rock	12¼	8786-9004
5	2-way drag	12¼	9004-9673
1	rock	12¼	9673-9792
1	2-way drag	12¼	9792-9891
2	rock	12¼	9891-10 158
1	2-way drag	12¼	10,158-10,210
7	rock	12¼	10,210-10,964
1	2-way drag	12¼	10,964-10,990
3	rock	12¼	11,010-11,461
19	rock	8¼	11,461-13,560 Total depth

Avg. per 12¼-in. 2-way drag bit ..... 332.8 ft.
Avg. per 12¼-in. rock bit ..... 118.4 ft.

Completion History

After cementing the liner with 500 sacks of cement, the packer was collapsed and pressure applied below it. A 14-min. drillstem test was made to test the cement shut-off between the 9⅝ in. casing and the liner. The shut-off did not hold and 20 bbl. of water and 250 sacks of cement were pumped in. Formation break-down pressure was 800 lb. Water pumped out at 800 to 2100 lb. and cement at 1600 to 2700 lb. Final pumping pressure was 2100 lb.

The interval between 13,475 to 13,490 ft. was perforated with a total of 90 shots and a one hour Johnson drillstem test made with the packer set 13,464 ft. At the beginning of the test the well had a 3000 ft. water cushion, a 3/16 in. choke on bottom and a ¼ in. choke on top. Thirty-one minutes later the water cushion hit the top choke and the working pressure rose to 200 lb. After 41 minutes the pressure reached 1500 lb. and the top choke was changed to ⅜ in. Forty-four minutes after the water cushion had blown out, the pressure reached a maximum of 2100 lb. and then leveled off at 1500 in 58 minutes. The operators recovered 120 ft. of condensate with a small amount of mud and sand at bottom. The bottomhole mud pressure was 8500 lb. Three and one-half inch tubing was run to 10,809 ft. and the packer set at 10,822 ft. The well when swabbed in began to flow salt water. Tubing was pulled and the drill pipe found a bridge at 12,700 ft. A cement retainer was set at 13,460 ft.; 130 sacks of cement with 500 gal. of mud acid ahead of the cement were

Below: Boiler barge containing four oil field type boilers, pumps, preheater, and treater. Right: Christmas tree of the world's former deepest producing gas well, Buckley-Bourg No. 1

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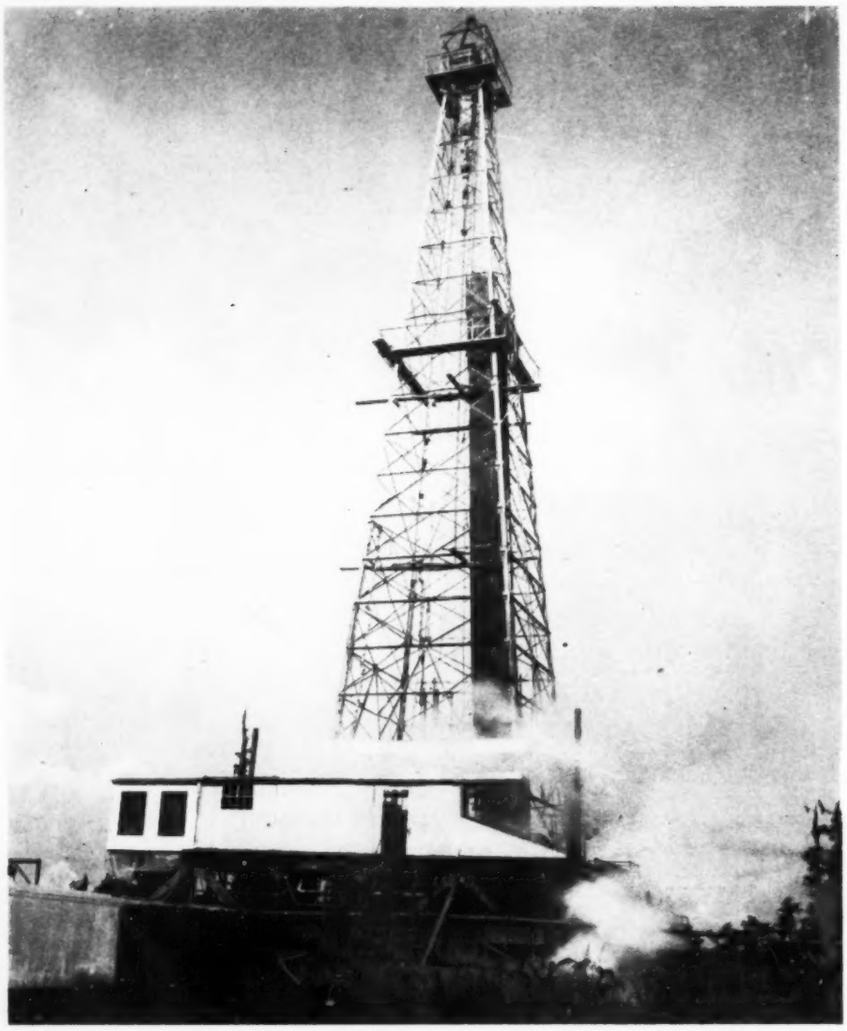

Rear and side view of drilling barge

used. The formation broke down at 4800 lb., 2200 lb. with water, and 1900 lb. with acid. Final pressure was 5100 lb. The cement and cement retainer were drilled out and the interval perforated a second time with 30 shots—2 shots per ft.—but the well flowed salt water on a second drillstem test. A second shale bridge was found at 12,750 ft.

Casing Leak

A third drillstem test was made with the packer set at 13,460 ft. with a ¼ in. choke on bottom and ½ and ¾ in. chokes on top and a 3000 ft. water cushion. The cushion reached the top in 16 min. with 500 lb. pressure. Twenty minutes after the tool was open the pressure reached 2000 lb. and with the water cushion out declined to 1150 lb. in 55 min. Five joints of condensate were recovered without salt water showing. The drillstem test had indicated a leak in the casing to the operator. The hole was found at 12,770 ft. and cemented with 250 sacks of cement. Formation broke down at 1000 lb.; 3800 lb. pressure was reached with the cement. Final pressure was 3000 lb. Soft cement was drilled out from 12,760 to 12,870 ft. and hard cement from 12,870 to 13,040 ft.

Tubing was run in the hole with a 5½ in. by 2⅞ in. packer set at 13,462 ft. The well was swabbed in. Tubing pressure was 4500 lb. and casing pressure zero.

A 1½ hr. test of the well through a ¼ in. positive choke flowed at an estimated rate of 5,970,000 cu. ft. per day with total pressure of 4300 lb. On a second 1½ hr. test through a ⅜ in. positive choke the well flowed at an estimated daily rate of 13,300,000 cu. ft. with total pressure of 4150 lb. Condensate production was not estimated.

Photographs and material for this article were supplied by United Gas Pipe Line Company.

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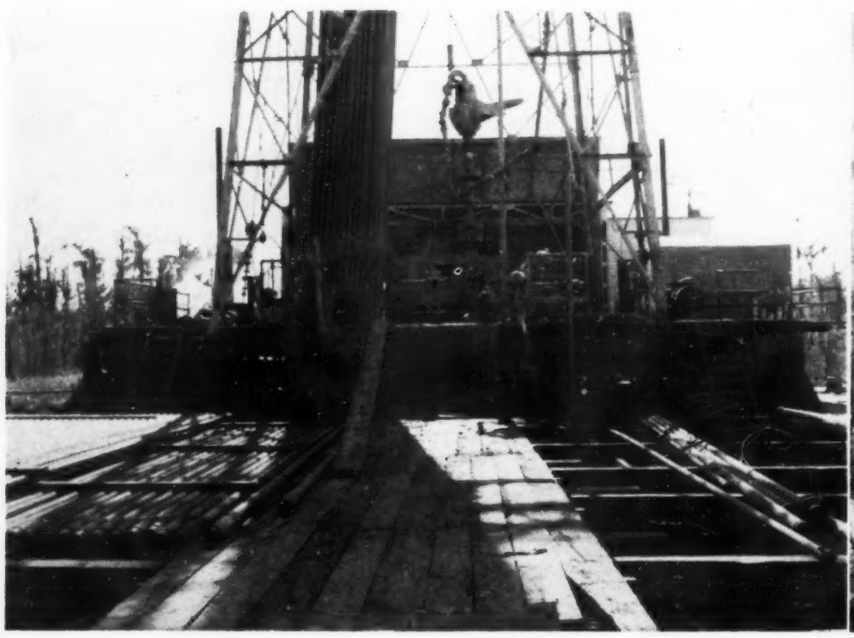
Pipe rack and floor of drilling barge. Breaking down drill pipe after completion



Well Histories Aid in Estimating Oil Reserves

PETROLEUM ENGINEER Exclusive Feature

☆ Past production records indicate future performance and supplement other determining factors

by Floyd K. Beach

ESTIMATION of oil reserves of a well, field, or group of fields is an important feature of petroleum engineering, but one not susceptible of exact mathematical treatment, owing to the number of imponderables normally present. A customary yardstick, usually applied to new fields, is an estimation of barrels per acre based on thickness of producing formation, porosity, and an estimation of the percent of the oil present that will be recovered. In order to determine the quantity a well will produce, one must assign a spacing pattern and hope that the well in question will yield the estimated proportion of the oil underlying what is assigned as the well's tributary area. Similarly, if the estimate is to cover a field, there must be some assumption regarding boundaries of the field.

As a field becomes more fully developed, however, production histories begin to tell a story, and the story becomes susceptible of interpretation into future performance. A graph of past performance usually shows that production begins to decline from the first and continues throughout the life of every well, and consequently a graph of production is often referred to as a "decline curve." The few cases where a well's production does not decline with age only go to emphasize the general rule when eventually the freak well begins its downward path. Decline curves alone may be misleading and the intelligent engineer will consider a number of factors before jumping all the way to a conclusion respecting future probabilities.

Sources of Energy

The energy that brings oil into a well, whence it may be brought into tanks at the surface, may come from gas drive, water drive, or gravity. If gas drive is the predominant energy, gas will be found dissolved in the oil, a gas cap is likely to overlie the oil, and the gas-oil ratio will be a valuable indication of the state of exhaustion already reached. Bottom-hole pressure is another indicator for gas-drive wells, and bottom-hole pressure normally declines almost in inverse proportion to the rise in gas-oil ratio.

FLOYD K. BEACH

Major, Royal Canadian Engineers (Reserve of Officers), is a member of the Engineering Institute of Canada, a professional engineer (Alberta), and a Dominion land surveyor—Born and educated in Michigan, he attended high school at Traverse City and college at Albion—He went to the Canadian West in 1906 and except for three years in the Canadian Expeditionary Force in the last war has remained there—Since 1927 has served with the Dominion and Alberta governments and the Petroleum and Natural Gas Conservation Board in administration of oil and gas laws; now with the latter as engineer in charge of oil and gas production records.

When energy comes both from gas and water drive, there may also be a gas cap, and even if no recognizable gas cap is present oil may contain gas in solution though in quantities normally below saturation conditions for the pressure and temperature existing in the reservoir. The gas so dissolved in the oil may for a time appear to be the predominant source of energy, although reservoir behavior will give some indication of the relative importance of gas or water as energy source.

If water drive is the predominant source of energy, the forecasting of reserves may become exceedingly difficult. Water will creep up the edges of a field; wells will show increasing proportions of water, and eventually produce so much water that further production is uneconomical, and the end-point of oil production may be reached when bottom-hole pressure and gas-oil ratio are still good. We recall, too, the case of a well in Mexico where oil was found in cavernous limestone. It flowed, went out of control, and about the only limit to its rate of flow was casing friction. Eventually water took the place of oil, and its career as an oil well ceased. Had pressure measurements been available, it is quite possible that only a moderate pressure decline would have been recorded from the initial day until water appeared. Again in fields producing from sandstone or running sand, lying flat or nearly so, and producing a heavy, viscous oil, water drive may be the predominant source of energy, but under conditions where forecasts based on decline curves become very hazardous.

We mention gravity as a source of energy, having in mind a report by H. C. Miller,[1] who shows that the Oklahoma City field produced about 200 million bbl. in five years while gas energy was being depleted, and almost an equal amount during the next five years. Miller reports that there was early movement of ground water, but water movement ceased at about the same time that pressure was exhausted, and gravity is the only remaining energy that can account for bringing oil to wells. It should be noted that this is an exceptional case. Adhesive force existing between formation rock and oil is normally sufficient to nullify much of the effect of gravity. This adhesive force is normally a function paralleling the viscosity or cohesive index of the oil.

The character of the producing zone and viscosity of the oil have a joint effect on the proportion of oil present that can be recovered. Cavernous limestone will yield up a large proportion of oil contained in it and the less viscous the oil the greater the proportion. The finer the grains in a sand or sandstone or the pores in a limestone and the more viscous the oil, the smaller the proportion. Again, either sandstone or

[1] U. S. Bureau of Mines R. I. 3634, "Oil Reservoir Behavior Based Upon Pressure Production Data."

limestone may have high porosity and low permeability. In limestones, secondary calcite may reduce permeability so materially as to make the rate of yield very low.

Well spacing may greatly affect the yield of a given well, and in studies of decline curves, some attention should be given to the dates of offset completions.

Studies in Canada

Having touched briefly on some of the more important factors influencing studies of reserves, attention is called to three examples, all taken from Turner Valley field, Canada. The field produces from limestone lying in a monocline dipping 30° or more, the upper edge somewhat overturned, with a gas cap in the upper portion. Below the oil, water has been encountered with a high salt concentration. There is little reason to suppose there can be accretion of meteoric water, and consequently any water drive can be only the result of elastic expansion of the body of water as pressure is released by production of oil and gas. One well has been abandoned because of increasingly large proportion of water, and another well near it has shown a small amount of salt water. The water level is somewhat higher in the older part of the field than in newer portions. We must assume therefore that there is some water drive, but the predominant energy is gas, and wells normally fail by draining oil from upslope until sufficiently large communication with the gas cap causes the gas-oil ratio to rocket. After this occurs, a well may be produced for short periods after resting to allow oil accumulation. After the discovery of liquid phase oil at the southern end of the then known gas field there was a period of unrestricted flow, after which there was a purchasers' proration, soon followed by a Conservation Board proration to existing markets and handling facilities. Conditions varied from time to time, but for some three years past a maximum yield of oil has been sought. The oil is of intermediate base, wax bearing, and sour (contains hydrogen sulphide and mercaptans). A few wells are troubled with waxing of tubing, and most of them require occasional dewaxing. With minor exceptions all wells flow. Gravity of oil runs about 42°A.P.I. on the average, but varies with structural position from about 38° at the bottom to 46° or even higher toward the gas cap and naphtha of up to 72° has been recovered in large quantities from the gas cap.

In Fig. 1 are plotted the data for Well A at a natural scale as barrels per day average for the calendar year, the mean daily production for the year being plotted at the mid-point of the period produced, and the plotted points have been connected by a smooth curve. Cumulative barrels to the end of each year are plotted at that point, and a smooth curve drawn. Extrapolation of the curves to the end of the ninth year

TABLE I
Well A — Oil Production

Year	Days	Production, bbl.	Bbl. per day	Cumulative, bbl.	M. cu. ft per bbl.
1	340	67,110	197	67,110	2.14
2	365	53,642	147	120,752	2.75
3	365	38,129	104	158,881	3.75
4	365	27,456	75	186,337	4.43

Fig. 1

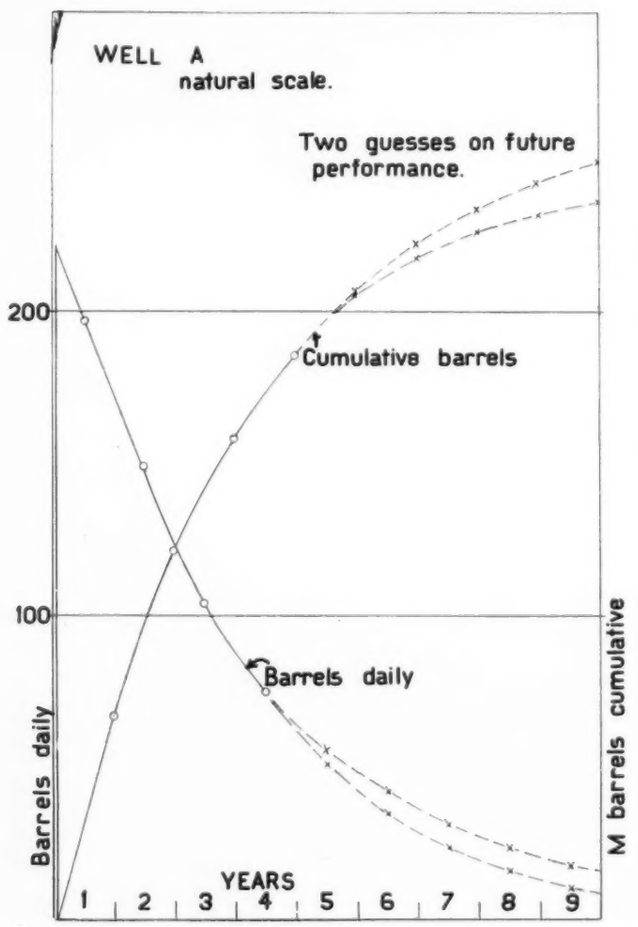
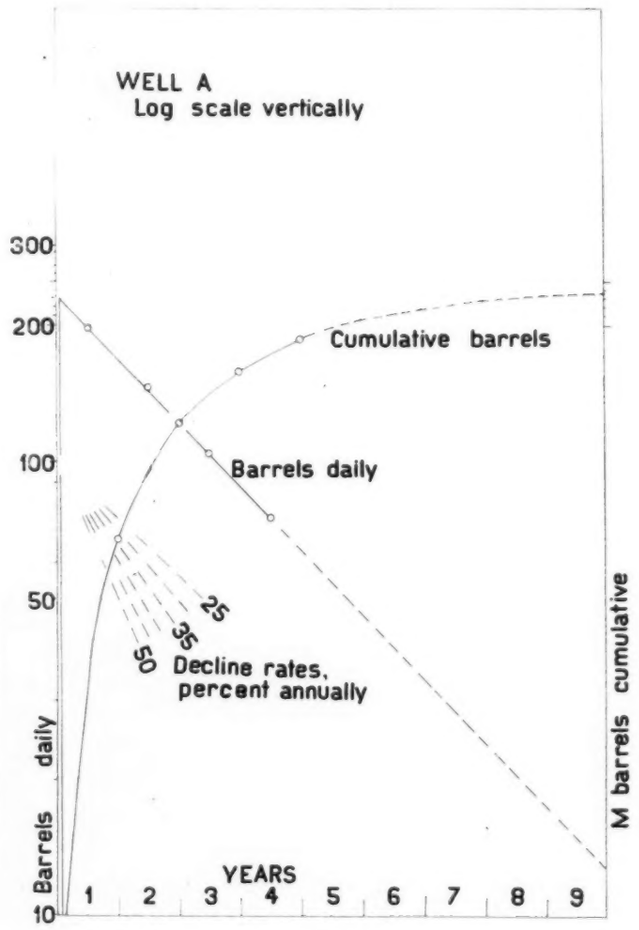


Fig. 2



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THE Oil Man, like the artilleryman, has to hit the bull's eye ... There isn't any room for guess-work. When it comes to cementing an oil well, you can't miss with Lone Star Cements ... they are specially made to meet the entire range of oil-field work:

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SET YOUR SIGHTS ON THE RIGHT CEMENT TO FIT THE JOB

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suggests that the well will then have dropped to a yield of 8 to 16 bbl. a day and will have yielded 235 or 250 M. bbl. At that point the gas-oil ratio will probably have gone high enough to warrant drastic restriction. Note that there is no good support for a choice between the curves of extrapolation drawn.

In Fig. 2 are plotted the same data, using a logarithmic scale vertically. In case of the curve for barrels daily, a straight line passes almost exactly through the four points. This shows that the mean annual decline rate is constant, and we have a geometric progression. We can select a first term a, read the common ratio r and, as it is a declining ratio (less than unity), the sum s of an infinite number of terms is:

$$s = \frac{a}{1 - r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this case r = 0.72 and s = first full year's production/0.28. As the first calendar year was not a complete year, read from the graph or look up from more detailed data that it amounted to 70 M. bbl. The ultimate cumulative production is therefore 70 M./0.28 or 250 M. But at the end there will be some of the curve not available. Assuming this will be after a daily rate of 10 bbl. is reached, how much will be lost?

TABLE 2

Well B — Oil Production

Year	Days operated	Total	Per day operated	Per day calendar	Cumulative	M. cu. ft. per bbl.
1	199	153,152	770	770	153,142	2.50
2	352	244,617	695	670	397,759	4.64
3	288	99,497	345	273	497,256	6.49
4	207	51,122	247	140	548,378	3.66
5	193	38,876	201	106	587,254	5.78
6	182	24,981	137	68	612,235	4.88
7	180	24,793	138	68	637,028	2.75

An approximation would be 10 × 365/0.28 or about 13,000 bbl., but this is not strictly true. If two points a short distance d apart have a ratio of r_d, then two points separated by n times d will not have the ratio nr_d but rather r_d^n.

If we use the notation:

r_d = daily common ratio,

r_m = monthly common ratio, and

r = yearly common ratio

we have the relations:

$$r_d^{30} = r_m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$r_m^{12} = r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$r_d^{360} = r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Equation (4) assumes a 360-day year, which is of course inaccurate, but it simplifies reckoning and the error is small in comparison with the approximation of multiplying a day's production by the number of days in a year.

In Fig. 2 lines have been drawn at varying slopes indicating the direction of the curve if the decline is 25 to 50 percent annually. Note that the value of r for annual decline of 25 percent is 0.75. That is, the annual decline in percent = 100 (1—r).

A table of reciprocals of (1—r)

Fig. 3

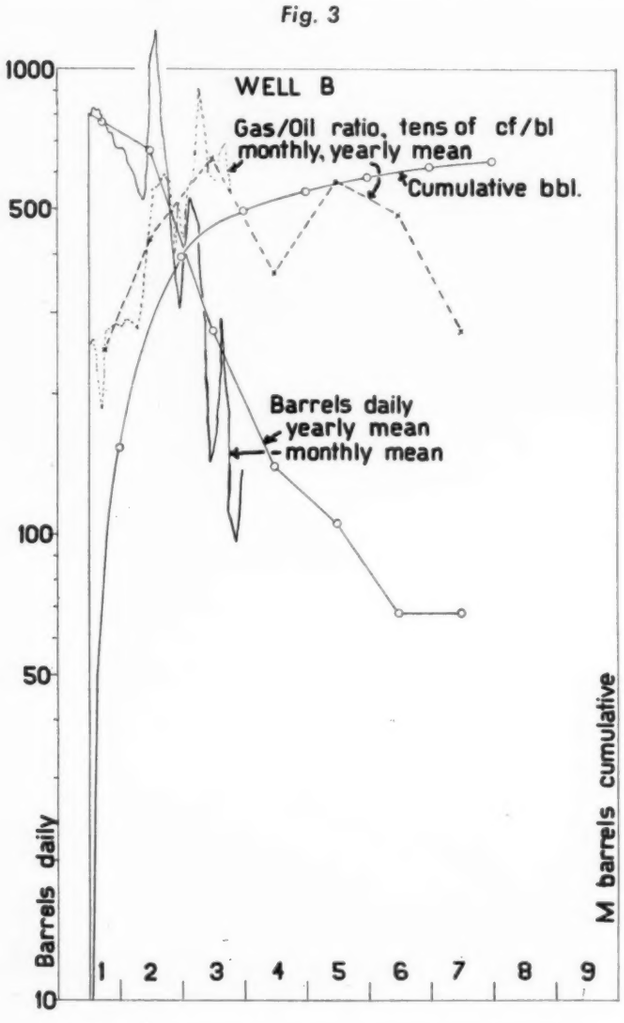
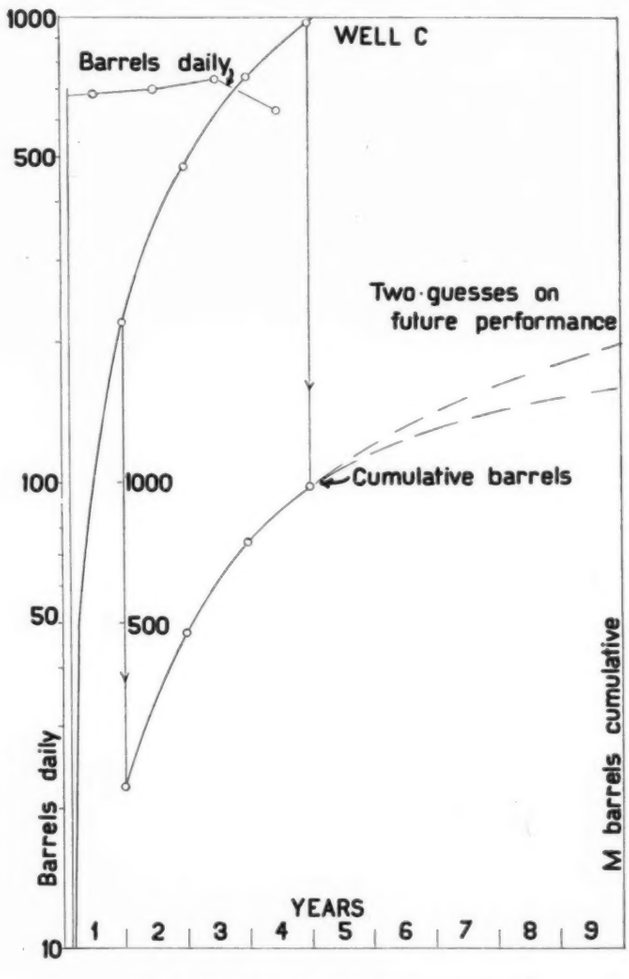


Fig. 4



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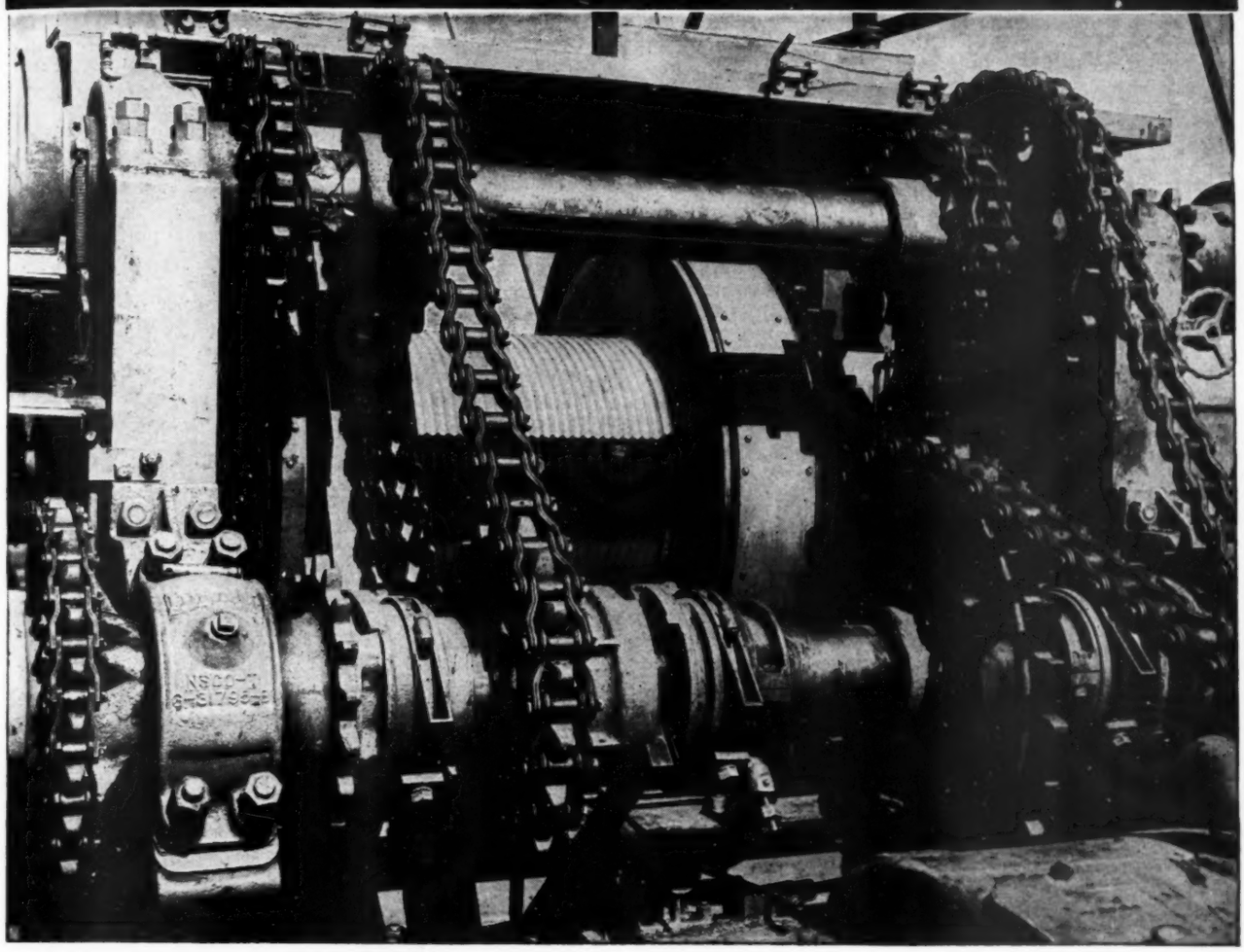

5 WAYS TO MAKE CHAIN DRIVES LAST LONGER:

- √ PROPER CLEANING
- √ PROPER ALIGNMENT
- √ PROPER ADJUSTMENT
- √ PROPER LUBRICATION
- √ WELL-FITTING SPROCKETS

● With American production at war, American industry must, of necessity, make the most of what it has . . . . must use it and *re-use* it, *carefully*. We know that users of Link-Belt Chain have good equipment, and our policy is to cooperate in every way possible to help them to make it last longer. To that end we offer this example of one operator's proper care of chain:

Pictured above is a set of chains (Link-Belt 3-Bar Hyper) which was removed when the drawworks went in for repair. The chains were thoroughly steamed, cleaned, inspected and dipped in oil. As a part of the drawworks repair job all sprockets were checked for wear and proper alignment . . . . were replaced where necessary. Now, back from the shop and being set up on location, all chains have been re-installed and properly adjusted. This equipment is again ready for new drilling service . . . . at "new chain" performance.

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would give us directly the factor that, multiplied by the first year's production, gives the ultimate yield.

In Fig. 7 is presented an alignment nomogram giving simultaneous values of daily, monthly, and annual decline rates, and the reciprocals are drawn at the right-hand side of each scale. Thus, a radial line through O cutting 28 percent annual decline indicates the corresponding monthly decline of about 2.7 percent and daily decline about 0.09 percent. It also indicates that 3.57 times the first year's production or 37 times the first full month's production, or 1100 times the first day's production, will give the ultimate yield *if* the decline rate holds and if the first term has been judiciously selected. It also shows that the portion of future production included in the first calculation, which is yet to be produced after a daily rate of 10 bbl. has been reached, is 1100 × 10 = 11,000 bbl. This compares with our first approximation of 13,000. One could also note that although the first day's production (from the graph) was 228, the average for the first year was 192, and 228 × 1100 gives about the same result as 70,000 × 3.57 or 250 M.

TABLE 3

Well C — Oil Production

Year	Days operated	Total	Per day operated	Per day calendar	Cumulative	M. cu. ft. per bbl.
1	323	221,082	684	684	221,082	0.81
2	339	255,695	754	701	476,777	0.96
3	347	268,743	774	736	745,520	0.84
4	364	231,013	635	633	976,533	1.09

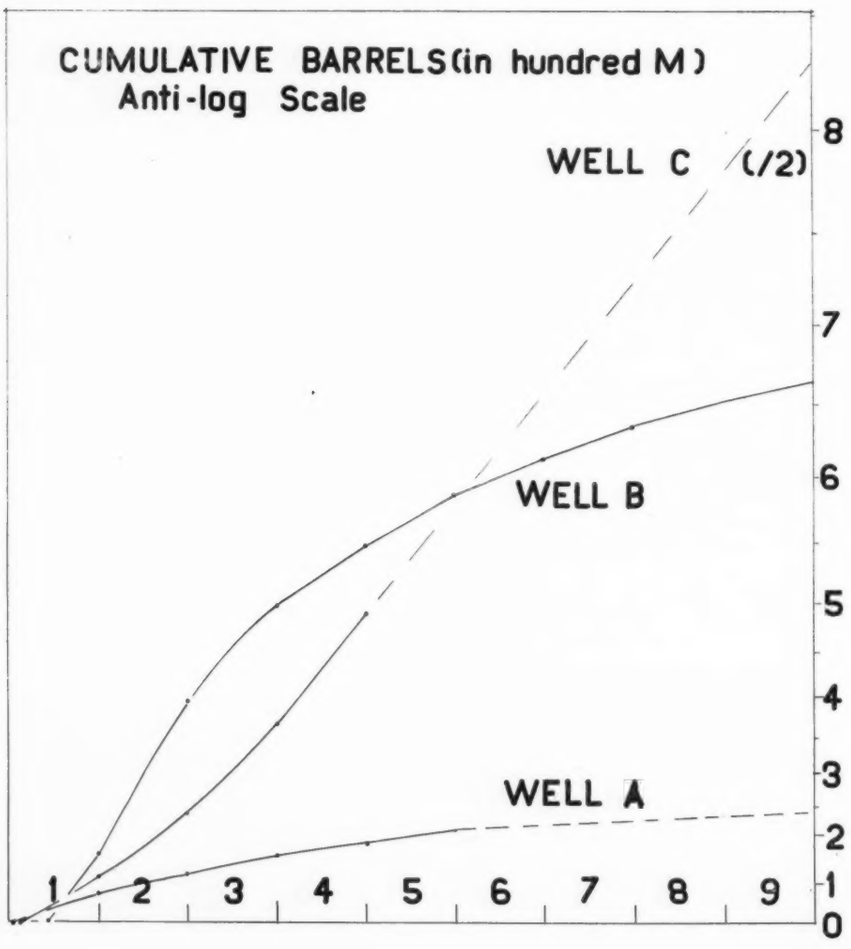
bbl. Deducting 11 M. bbl. for the last stages after 10 bbl. per day has been reached, we have 239 M. bbl. as the ultimate economic yield.

In Fig. 5, plotted to a vertical anti-log scale, note that a fairly flat curve leads to this point at the end of the ninth year. The shape of the curve of cumulative barrels at log scale (Fig. 2) is least fitted for extrapolation owing to sharp curvature. Note at this time the cumulative curve in Fig. 3. Although it flattens out and tends to approach an asymptote, the scale becomes increasingly small as we approach the part where we most want information. At a natural scale (Fig. 1) the graph of cumulative barrels is less sharply bent than in Fig. 2 but its shape and the scale relations are less favorable than at anti-log scale.

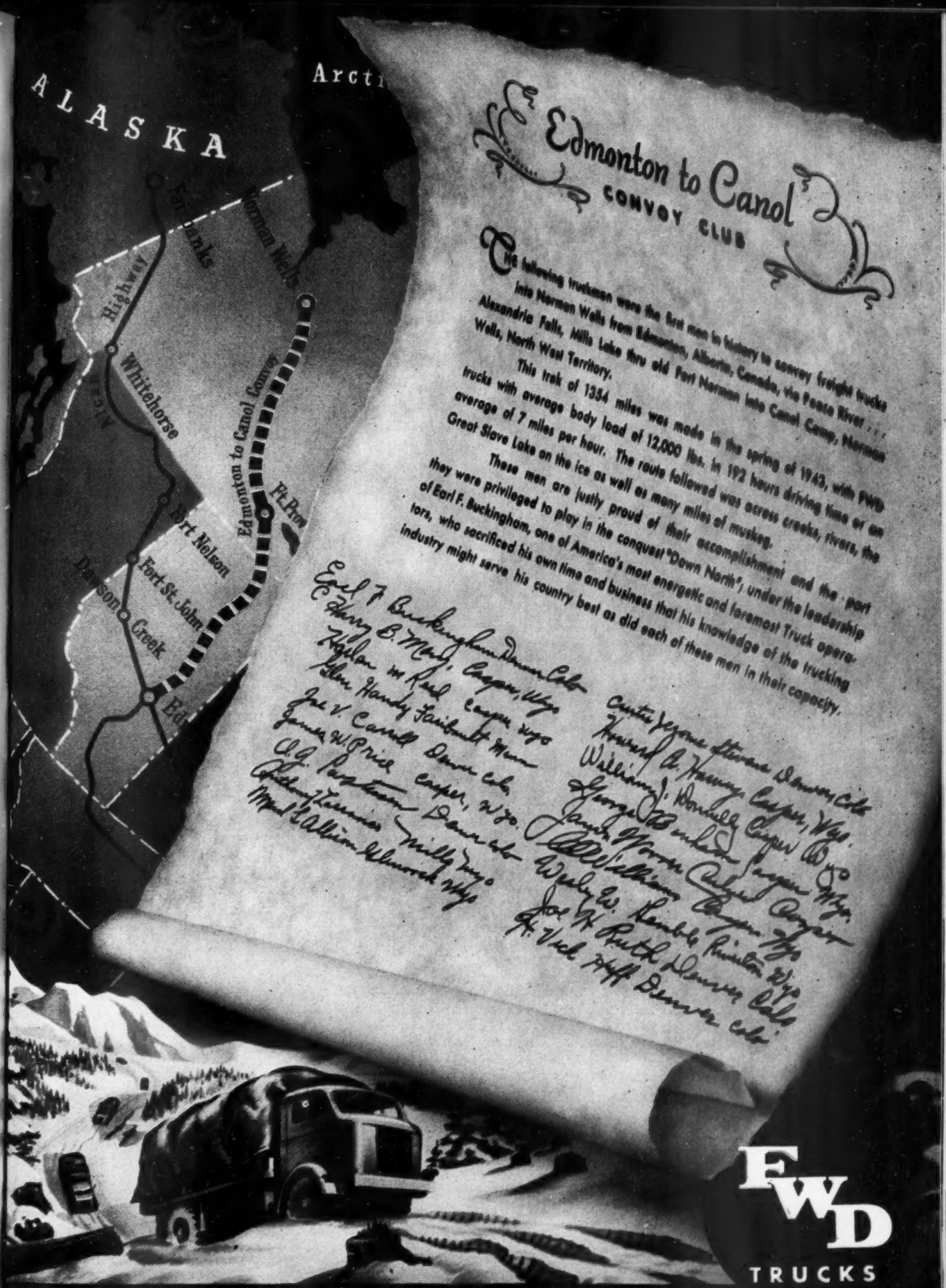
Here it will be noted that after the second year the well was operated only part time, and we have consequently entered two daily rates, first for the days operated, and then for the calendar days. If we so wished, we could plot the decline curve as barrels per day operated, in which case we should compress the time scale correspondingly after the fashion of proposals by Cutler and Johnson.[2] After trying the scheme, however, no more definite conclusions could be reached than by plotting production per calendar day, and this has been done in Fig. 3. This is also at a vertical log scale as is the cumulative graph. Neither curve has been extrapolated in this figure. The erratic character of the decline curve leads to questions concerning the reasons for anomalies. To explain some of them we have plotted average daily production for each month of the first three years as an irregular solid line, and the gas-oil ratio as a broken line. Note that after a period of decline from 800 to 500 bbl. per day, production was increased to 1000 and then 1200 bbl. a day. Concurrently, gas-oil ratio jumped alarmingly and did not immediately fall when the heavy draft ceased. Three subsequent spurts in production were accompanied by jumps in gas-oil ratio. At last, in the seventh year, after long periods of intermittent production, the ratio seemed to be settling to a reasonable figure. With these facts in mind, we must ask whether the well has really been curtailed, even if on half-time production. Table 2 shows a production per calendar day of 68 bbl. maintained for two years without decline, but if we draw a straight line in Fig. 3 from the start to the mean point of the seventh year it has a slope of 35 percent annual decline. From Fig. 7, 35 percent annual decline promises 825 times the daily rate or, say, 56 M. bbl. yet to be produced, and this might be discounted by, say, 8 M. bbl. for the period after 10 bbl. per day. The well is fairly high on structure, with the probability that as exhaustion approaches the gas-oil ratio will rocket, and until more is known about future performance this is probably a conservative estimate.

In Fig. 5, Well B cumulative curve

Fig. 5



[2] "Estimating Recoverable Oil From Curtailed Wells," by Willard W. Cutler, Jr., and Harry R. Johnson, *Oil Weekly*, May 27, 1940.


ALASKA
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Fairbanks
Norman Wells
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Whitehorse
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The following truckmen were the first men in history to convey freight trucks into Norman Wells from Edmonton, Alberta, Canada, via Peace River ... Alexandria Falls, Mills Lake thru old Fort Norman into Canol Camp, Norman Wells, North West Territory.
This trek of 1334 miles was made in the spring of 1943, with FWD trucks with average body load of 12,000 lbs. in 192 hours driving time or an average of 7 miles per hour. The route followed was across creeks, rivers, the Great Slave Lake on the ice as well as many miles of muskeg.
These men are justly proud of their accomplishment and the part they were privileged to play in the conquest "Down North", under the leadership of Earl F. Buckingham, one of America's most energetic and foremost Truck operators, who sacrificed his own time and business that his knowledge of the trucking industry might serve his country best as did each of these men in their capacity.
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Harry B. Mack, Casper, Wyo
Waylan M Reed Casper Wyo
Glen Handy Fairbanks Alaska
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George Mc Mahon Casper Wyo
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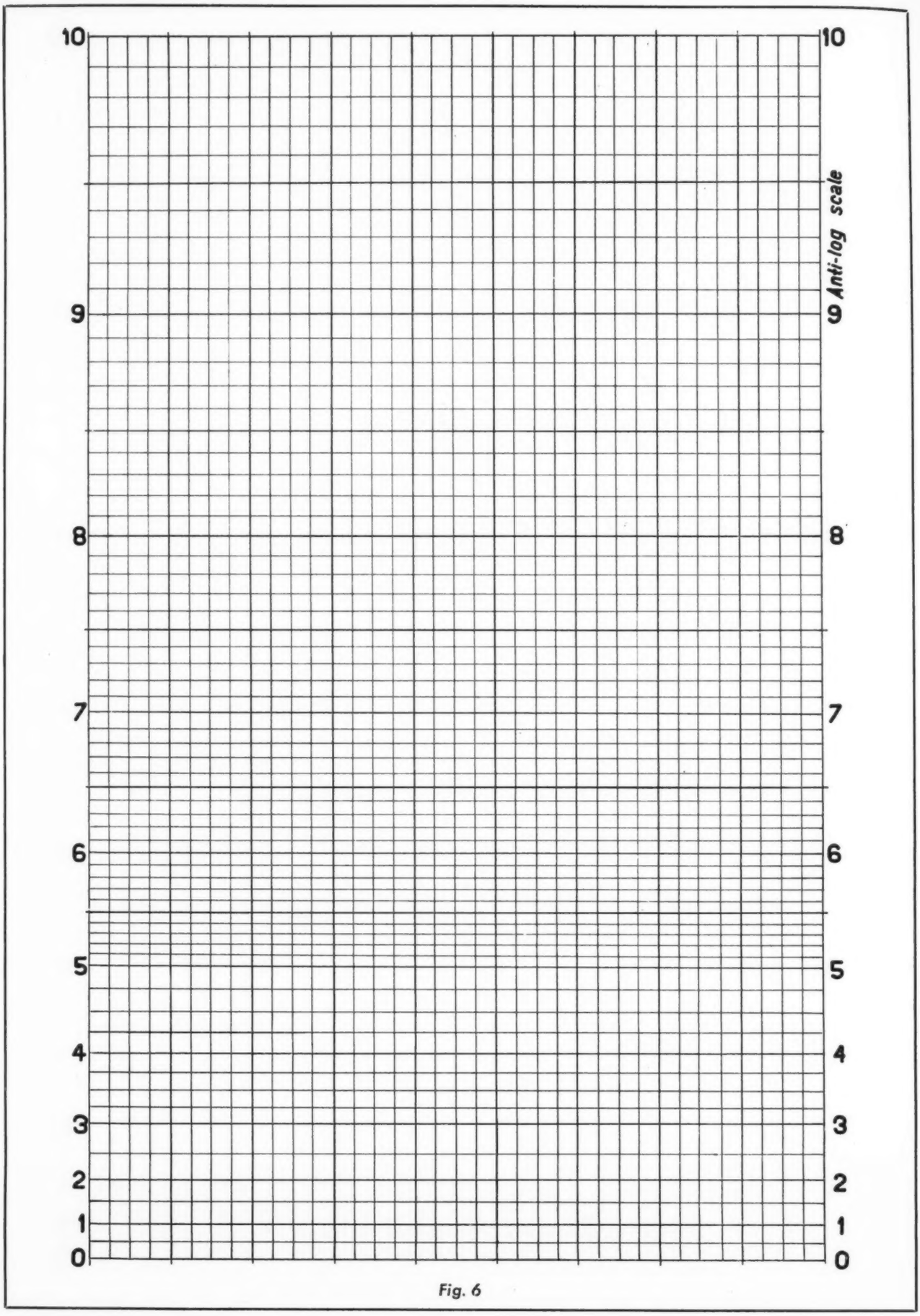

Fig. 6

ANNOUNCING

The Purchase of Dailey-Owens Tool Company

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WE have purchased the Dailey-Owens Tool Company and established a Fishing Tool Department of Hunt Tool Company in charge of Arch Owens, former co-owner of the Dailey-Owens organization.

It is our endeavor to build a Fishing, Cutting and Shooting Service that will give the Gulf Coast the most efficient organization of its kind.

This service is now available from our Houston and Houma shops and will shortly be available from four other Hunt shops . . . Bay City, Corpus Christi, Jennings and Harvey.

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Houston, Bay City, Corpus Christi, Jennings, Shreveport, Harvey

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has been extrapolated to the end of the ninth year as 665 M. bbl., with the curve still rising. As with Well A the anti-log curve has characteristics that make for greater confidence in extrapolation than the log scale.

Here, too, there is room for choice in the second and third years between bbl. per day operated and bbl. per calendar day, and again, to avoid compressing the time scale, we have in Fig. 4 plotted the calendar day average. The fact that the daily production continued to rise slowly to the end of the third year and then to decrease only moderately, and that the gas-oil ratio has shown very moderate increase may be explained in part by modest production rates, and by the fact that it is low on structure and has not had an offset on any 40-acre parcel adjoining. Bottom-hole pressure decline has been relatively small—roughly in reciprocal proportion to the rise in gas-oil ratio. Taking all factors into consideration, there is also a suggestion that water drive may to a measurable extent be responsible for the characteristics of the curve, and the well's useful life may terminate with inflow of salt water, rather than, as in so many cases, with mounting gas-oil ratio. The cumulative curve in Fig. 4 is uncertain of extrapolation, but when plotted in Fig. 5 at anti-log scale (using half quantities in order to keep within the limits of the scale), there is a suggestion that it can be continued as a straight line. One could therefore assume that by the end of the ninth year, if no offset is drilled, and if salt water has not shown up, it will still be producing at a rate of close to 100 M. bbl. annually and will have produced some 1660 M. bbl.

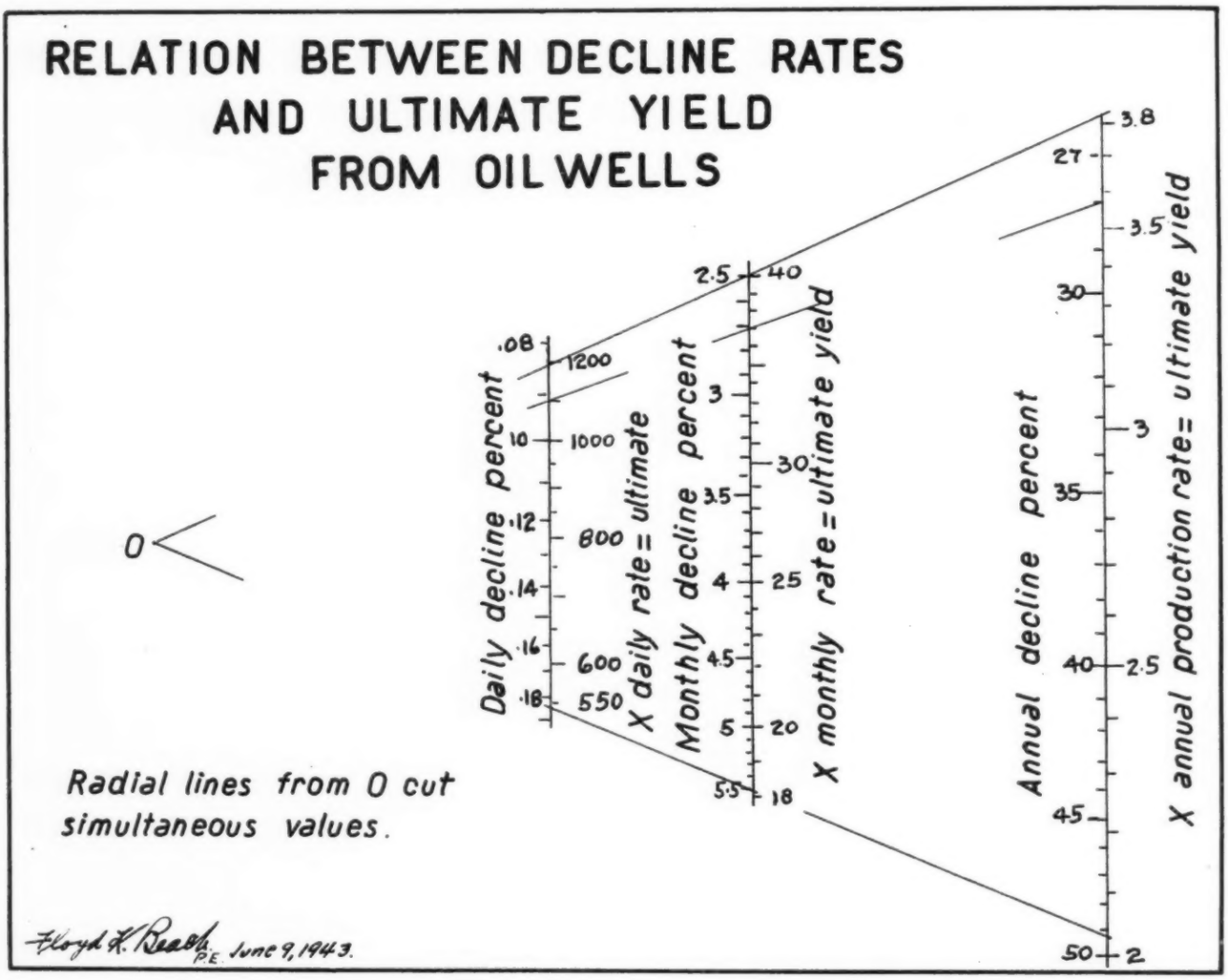
Hasty sketches of cumulative curves at anti-log scale have been made of all Turner Valley oil wells. Well A is an ideal example of the usual type of depletion curve, and no other well has had quite so uniform a history. Well B is an extreme case of the same general type of depletion curve, and few wells have so erratic a history, but range somewhere between the two. Well C has no parallel among others now producing, but there were two analogies among wells in the gas cap.

In general, graphs of cumulative production plotted at semi anti-log scale can be extrapolated with greater confidence than at either natural or semi-logarithmic scales. Estimates of reserves indicated for various decline rates as covered in Fig. 7 can be used to confirm or amend estimates based on extrapolation of cumulative curves.

Fig. 6 is a reproduction in page size of a sheet of semi-anti-log paper with which the reader who is interested may experiment. Use of this page with plots on transparent paper overlaid will enable studies to be made of a wide range of well histories from the one sheet of coördinate paper. We know of no manufacturer who makes this scale of coordinate paper.

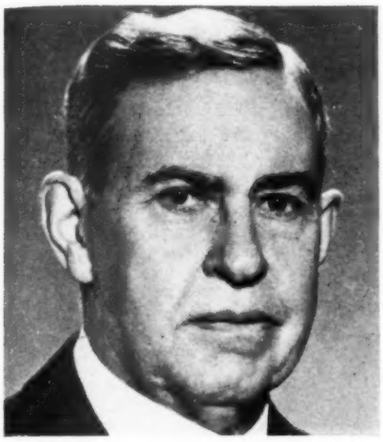
☆ ☆ ☆

Fig. 7



Triptane—Powerful Component of Aviation Gasoline

☆ New process makes possible its manufacture commercially



PROF. V. N. IPATIEFF

TRIPTANE is the most powerful hydrocarbon known for use in internal-combustion engines. Its anti-knock properties are of such magnitude that no commercial engine has been built capable of utilizing the full power value of pure triptane. When used as a component of aviation gasoline, it greatly enhances the performance of present-day aircraft engines and makes possible the design of future engines of even greater power and efficiency.

Although its existence has been known for years and some of its physical properties have been determined, triptane has been a laboratory curiosity because the known methods of producing it involved the classical but impractical Grignard reaction, or zinc dimethyl as a reactant. The cost to produce triptane in very small amounts in the laboratory by these methods has been more than $3000 per gal. It has been reported that a batch of several hundred gallons of triptane was produced within the last two years for experimental purposes at a figure of $40 per gal. Even if the cost did not preclude the use of triptane for war purposes, the consumption of critical materials needed to produce it by previously known methods would not justify its production.

American petroleum industry set out to discover a reaction to produce triptane and to develop a feasible process for large production. Again industry has succeeded.

Now Commercially Productive

To make triptane in large quantities by practical methods was heretofore considered impossible. Two American scientists, however, were undeterred. Dr. Vladimir Haensel, research chemist, and Prof. V. N. Ipatieff, director of chemical research of the Universal Oil Products Company, working with materials at hand and available in quantity made the discovery that makes possible immediate commercial production of this amazing fuel.

Haensel and Ipatieff, together with Universal's technical staff, make possible the production of triptane at an estimated selling price of less than $1.00 per gal. Their discovery removes this magic hydrocarbon from the shelf of the chemical museum, making it available as a powerful war-time weapon.

High Yields Obtained

The process consists of two steps. The second step of the process involves the formation of triptane from a selected charging stock produced in the first step. Based on the material charged to the second step, liquid recoveries of more than 90 percent are obtained of which more than 50 percent is triptane.

The process, when operated to make the largest quantity of triptane available as a blending agent, yields two other valuable hydrocarbons, in themselves of great value in aviation blends. These hydrocarbons, 2,3-dimethylbutane and 2,3-dimethylpentane, are superior to alkylate as blending agents for aviation gasoline.

The following are physical properties of individual hydrocarbons produced by this process:

Compound	*B.P., °C.*	*M.P., °C.*	*Refractive index, nD^{20}*	*Specific gravity*
2,3-dimethylbutane	58.0	—128.8	1.3750	0.6620
2,2,3-trimethylbutane (triptane)	80.8	— 25.0	1.3894	0.6901
2,3-dimethylpentane	89.7	.....	1.3920	0.6944

The relatively high freezing point of pure triptane does not preclude its use in aviation fuels. Blends containing up to about 85 percent triptane do not freeze above minus 78°C. (minus 108°F).

The product of the reaction is saturated and free of impurities so that no additional refining treatment is necessary to permit its use in aviation fuels. The process has been operated to date for 300 hours in a pilot plant with no indication of decline of catalyst activity.

No new or unusual materials are needed for the reaction or process. The raw materials are condensable gases produced in petroleum refineries as by-products of catalytic and non-catalytic cracking or reforming of petroleum oils. The catalysts are readily available in large quantities. No special equipment or materials used in the process plant are necessary other than regular equipment employed in refineries. The temperatures and pressures employed are well within refinery experience.

DR. VLADIMIR HAENSEL

The Inventors

Dr. Vladimir Haensel, 28 years old, is employed as a research chemist by Universal Oil Products Company. He has B.S. and Ph.D. degrees in chemistry from Northwestern University, and a M.S. degree in chemical engineering from Massachusetts Institute of Technology.

Prof. V. N. Ipatieff is internationally known to chemists. The oil industry knows him as the discoverer of numerous catalytic reactions and processes. He celebrated his 75th birthday last fall. In the first World War, he was a general in the Russian Army in charge of chemical industries. In this, his second World War against Germany, he is an American citizen and has scored again against his old enemy. Processes discovered by Ipatieff and his co-workers at the Universal Oil Products Company Research and Development Laboratories in Riverside, Illinois, are basic contributions to America's superior aviation fuels.

☆ ☆ ☆

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ELECTRONICS
Laboratory model of a Westinghouse Mass Spectrometer. The ionized gas molecules move at high velocity through a controlled magnetic field which sorts out the molecules according to their weights.
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Climaxing 20 Years of Research, Westinghouse now introduces a scientific instrument of tremendous importance to the petroleum, chemical, and synthetic rubber industries.

The Mass Spectrometer, it's called. By means of this electronic device, gas analysis which previously took days can now be completed in a matter of minutes. Purity of the gases being analyzed can be determined within a fraction of one per cent.

For Quick and Accurate Analysis of the purity of gas components, essential to insure product quality in the production of synthetic rubber and high octane gasoline, this new electronic method offers broad possibilities. Production rates may be greatly stepped up, because delays involved in complicated laboratory analysis are eliminated. Waste production may be sharply reduced, because purity of ingredients can be accurately determined, and deviations from fixed standards detected almost immediately.

So Significant is this Westinghouse development to the synthetic rubber, chemical and petroleum industries that several leading representatives of these industries have been working for months, side-by-side with Westinghouse engineers, to perfect its application.

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TO FACILITATE ITS USE the Mass Spectrometer has been developed as a wholly self-contained unit. The only outside connections required are for 110-volt a-c power, and water for cooling pumps.

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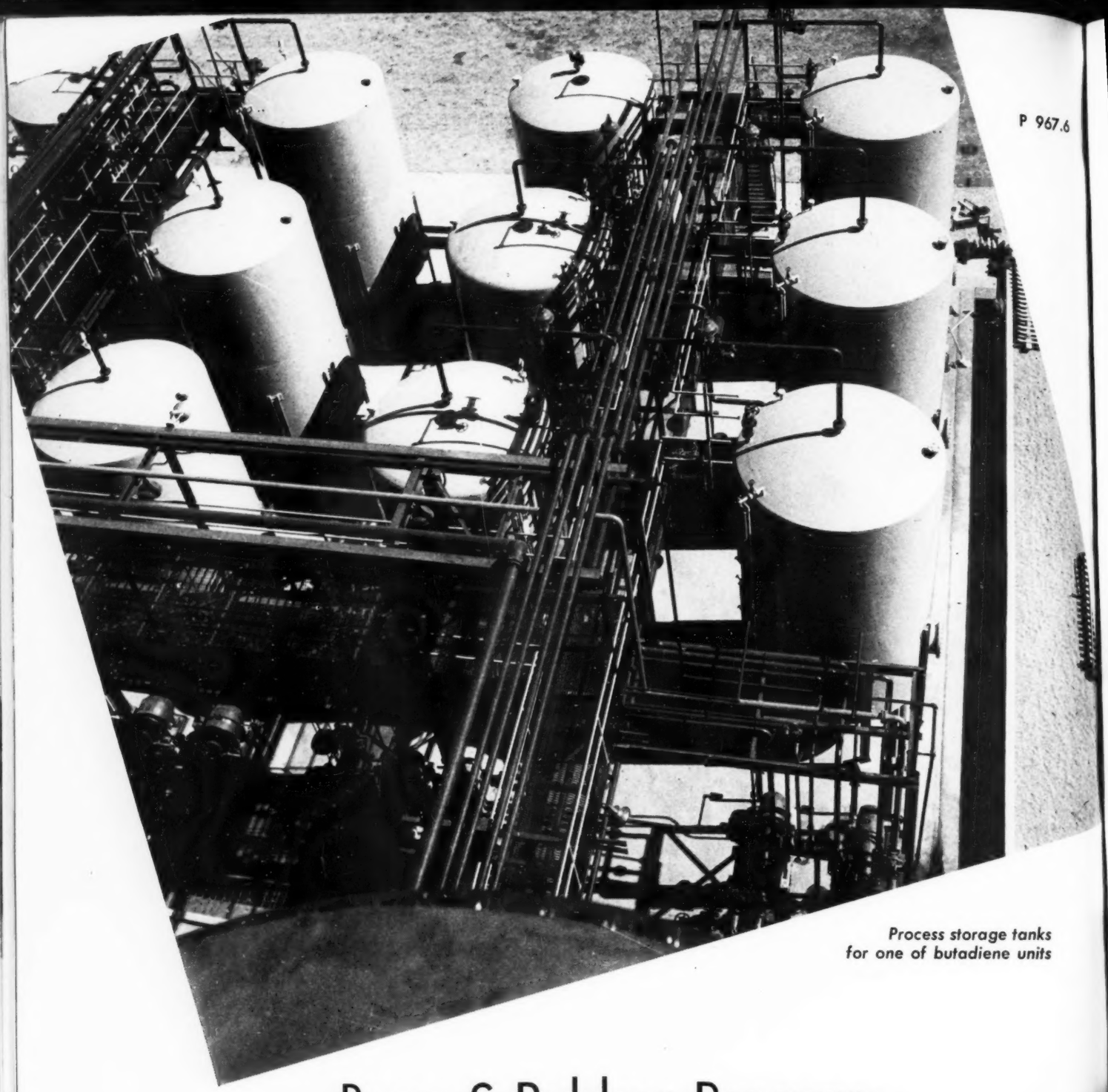

Process storage tanks for one of butadiene units

Buna S Rubber Program

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☆ Plant design standardized—Institute, West Virginia, installation typical

by S. T. Russell, Blaw-Knox Company

BEFORE the end of this year an entirely new process industry will be in full operation supplying more rubber than was formerly imported by the United States under normal peacetime conditions. Many of the plants already are in operation and within the next few months the last of the units will be in production providing the United States with a capacity of 850,000 long tons a year of various types of synthetic rubber. This will compare with an average pre-war importation of 650,000 long tons of natural rubber a year. The new plants will be highly economical in manpower, employing only about 20,000 persons to produce an amount of rubber that ordinarily would require 400,000 natives to gather.

The program is getting into operation just in time to prevent an acute shortage of rubber for the essential needs of the United States and our Allies. In his third progress report, Rubber

Director William M. Jeffers analyzed the situation as follows: The inventory of natural rubber at the beginning of 1943 amounted to 443,000 long tons. Imports of natural rubber from sources still open to us are estimated at 54,000 long tons for this year. Production of synthetic of the four principal types from plants being completed this year will reach an estimated 254,000 long tons, giving a total estimated supply of 751,000 long tons. Estimated essential requirements for the year amount to 609,000 long tons. This will leave a balance at the end of 1943 of only 142,000 long tons, which constitutes a minimum working reserve.

With the full synthetic program in operation, producing 850,000 long tons, a stock pile again can be built up and some relaxation in distribution of tires for essential civilian use will probably be permitted. Director Jeffers has said: "My notion is that by the autumn of 1944 you can forget rubber as a problem in this country. There will be enough for all needs."

The first step in adopting a general rubber program for the nation involved the selection of types of rubber to be made. No synthetic rubber is exactly like natural rubber. Each has its good points and its weaknesses. Some of these good points are considerably better than those of natural rubber. For this reason the relatively small amounts of synthetic rubbers produced commercially before the war were manufactured in order to make use of their individual properties for specialized purposes.

The principal commercially produced synthetic rubbers are buna S, buna N, neoprene, butyl, and the thiokols.

THE AUTHOR

S. T. RUSSELL attended Syracuse University, receiving degrees of bachelor of science and master of science—He became affiliated with the Process Engineering Division of Blaw-Knox Company in 1939, previously having been with the Semet Solvay Corporation—His work with Blaw-Knox has involved engineering and designing of equipment for various chemical process industries and in the last two years has been devoted exclusively to synthetic rubber.

Synthetic Rubber Program

In drawing up a general program, about four-fifths of production was assigned to buna S because this material more nearly resembles natural rubber than the other products and because it can be milled and processed by most existing rubber equipment. The program finally developed called for 16 buna S plants containing 24 standard units and having a total annual capacity of 735,000 long tons. Butyl was assigned a capacity of 75,000 long tons and neoprene 40,000 long tons.

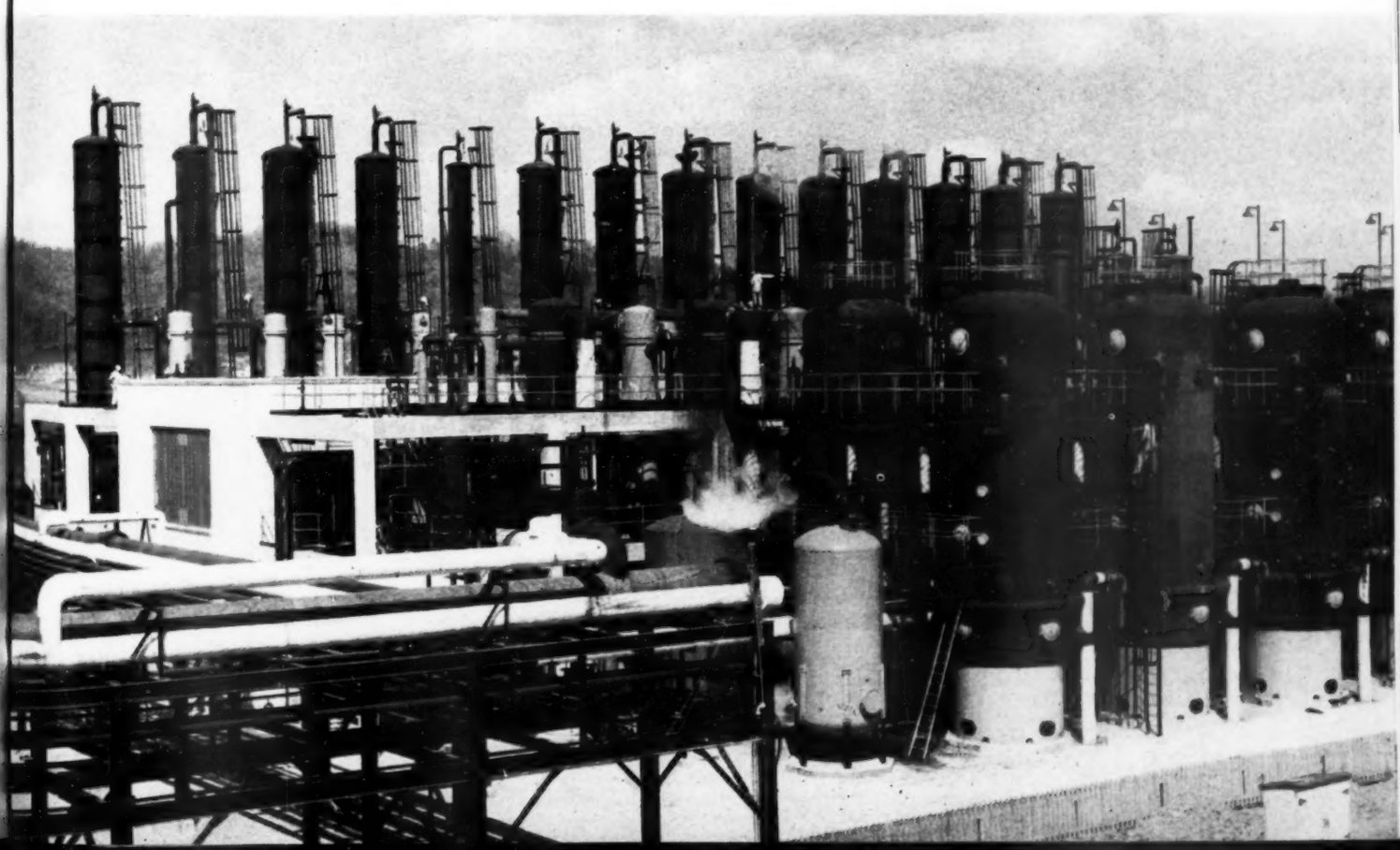
Once the general program was established, it became apparent that a standard design for all buna S plants would be highly important as a means of conserving engineering skill and simplifying and speeding up construction work. The wisdom of adopting a standard design became apparent during the construction period, as it was possible to divert equipment from one job to another to meet individual variations in progress.

Even before the adoption of the general program, the process equipment division of the Blaw-Knox Company had been active in the design and construction of buna S plants. The first two jobs undertaken by the Blaw-Knox Company were a plant for the Firestone Tire and Rubber Company at Akron, Ohio, and a plant for the United States Rubber Company at Naugutuck, Connecticut. The original job at Naugutuck called for only a pilot plant, but the need for synthetic rubber had become so great that work was begun on a 15,000 ton unit even before the pilot plant was ready for operation.

The Blaw-Knox Company was engaged to prepare the fundamental and functional equipment designs for all the standard buna S plants in the program. The knowledge and research facilities of the leading rubber companies were pooled to develop the standard design.

In addition to making these standard designs, Blaw-Knox was awarded equip-

A unit for the manufacture of butadiene, component of buna S rubber

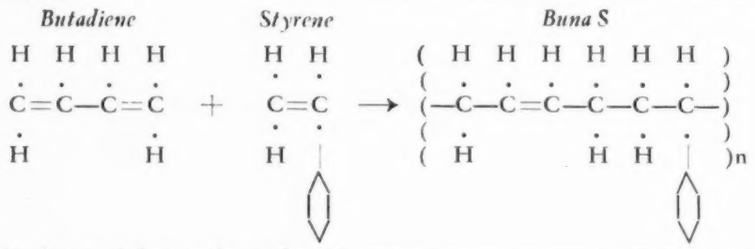


Carbide and Carbon Chemicals Corporation plant showing stacks and towers silhouetted against the evening sky

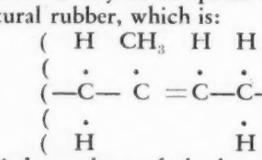
ment and installation contracts for seven of the buna S plants containing seven standard units, each of which was planned for a capacity of 30,000 long tons a year.

Buna S

Buna S is a copolymer of butadiene and styrene, about three times as much butadiene being used as styrene. The two materials are emulsified in a soap solution in the presence of a catalyst under careful pressure and temperature control. The reaction may be indicated as follows:



The theory of the reaction is that the butadiene and styrene molecules form long chains, that is, they are copolymerized into long molecules. The structure of buna S may be compared to that of natural rubber, which is:



A large share of the buna S plants are built adjacent to butadiene plants, although in some cases butadiene is shipped in by tank car. Butadiene may be produced either from petroleum or from alcohol derived from grain or other products. As butadiene is a gas at normal temperature, having a boiling point of minus 5°C., it is handled under pressure in liquid form. When stored in large quantities, it is placed in spheres, which may be cooled by evaporation of sprays of water or other means.

Styrene is brought to most of the plants by tank cars and stored in cylindrical tanks. At the large United States Rubber Copolymer plant at Institute, West Virginia, however, the adjoining plant of the Carbide and Carbon Chemical Company supplies both the butadiene and styrene, material being transferred by pipe lines.

Styrene is made from ethylene, a petroleum by-product, and benzene, which may be distilled from coal tar or derived from petroleum.

Standard Buna S Plant

Standard buna S copolymer plants consist of units having a capacity of 30,000 long tons of rubber a year. The plants range in size from one to three units, the three-unit plant of the United States Rubber Company at Institute, West Virginia, being one of the largest. In the standard design every effort has been made to use equipment of a type readily available or which could be manufactured from existing designs. Tailor-made equipment has been limited to a relatively few special items. The use of some standard equipment of a type regularly installed in petroleum refineries has permitted some needs to be met from a great many sources of supply and has avoided many unnecessary special designs. Most of the smaller plants have been laid out so that additional standard units can be installed with a minimum of interruption to operation of the original units.

The standard plants, of which the one at Institute is typical of the others except in size, are laid out in regular production areas including a laboratory. The Institute installation is laid out as follows:

The area at the chemicals end consists of a tank farm for the storing of newly received butadiene and styrene as well as tanks for storing the recovered butadiene and styrene. There also is liquid chemical storage for such materials as sulphuric acid and caustic soda solution. There is a water pump house, facilities for raw water treatment, a cooling tower, facilities for brine purification and preparation, and a safety flare consisting of a burning stack with a water-sealed base and a constantly burning flame at the top.

A total of 24,000 gal. per min. of water will be circulated when the plant is running at full capacity of 90,000 long tons of buna S per year. Twenty-four thousand gal. per min. is equivalent to 34,560,000 gal. per day, which is sufficient water to service a community the size of Cincinnati, Ohio, with approximately 460,000 inhabitants.

Air will be used for general services throughout the plant to feed air-operated tools.

Instruments throughout the plant are also operated by means of air. Throughout the plant, services are equipped with duplicate machines to forestall shutdown from interruptions. The instrument air is dried to remove traces of water that would cause blockage of lines with ice during winter.

Process water is softened by means

FOR SYNTHETIC RUBBER PRODUCTION

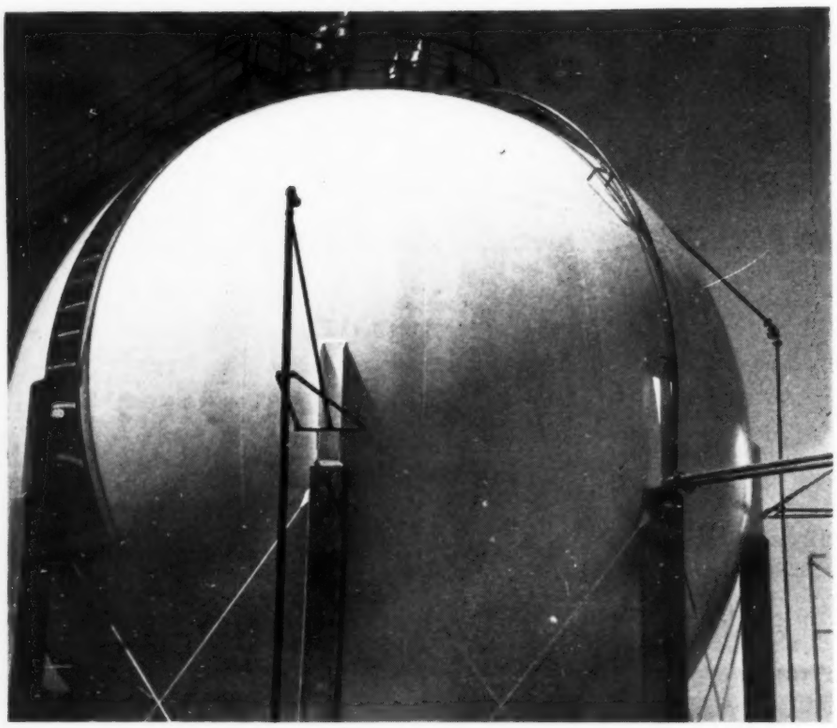
Selected by the Rubber Committee for installation in all standard synthetic rubber plants of the Rubber Reserve Corporation, these proportioning pumps for blending regular and off-grade latex are typical of the several types of proportioning equipment developed by %Proportioneers, Inc.% for the synthetic rubber and other process industries. As pioneers in the development and perfection of proportioning equipment, long experience in allied industries is brought to bear on each specific problem. With complete manufacturing facilities "under one roof", %Proportioneers, Inc.% control every step in the production of their equipment — from casting to final inspection. Such close supervision, through every phase of machining and assembling, assures uniform high quality in every %Proportioneers% unit . . . and guarantees delivery on time.

Write for descriptive Bulletin 1700

Photo courtesy U. S. Rubber Co.

% PROPORTIONEERS, INC. %

WRITE TO %PROPORTIONEERS, INC.%, 28 CODDING STREET, PROVIDENCE 1, RHODE ISLAND



Hortonspheroid tank for storage of butadiene

of a plant using an artificial Zeolite as the base exchange medium. After 42,000 gal. of water have been softened, a brine solution is passed through the bed to wash out the absorbed calcium carbonate hardness.

Softened water is required, as the process is predicated on a soap emulsion of a mixture of butadiene and styrene. Hard water forms a scum with soap, which might be retained by the synthetic rubber and interfere with quality.

The cooling tower is designed to lower the temperature of 20,000 gal. per min. of 100°F. water to 80°F. during summer operations. This unit is provided with fans, capable of circulating 1,500,000 cu. ft. of air per min.

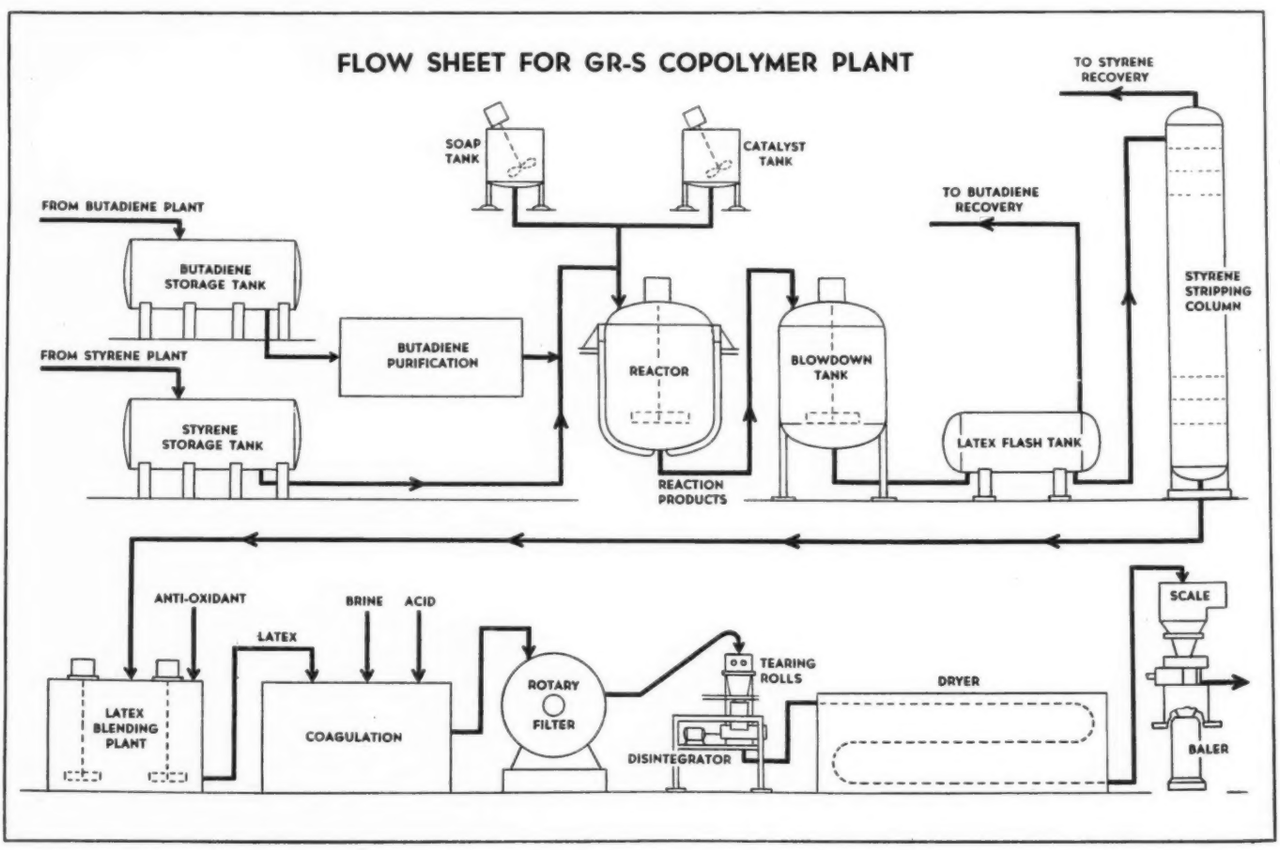
Storage facilities are provided for butadiene and styrene.

The butadiene tankage is elevated to provide a positive pressure head on the butadiene transfer pumps to prevent vapor lock, which is a troublesome operating condition when handling very volatile hydrocarbon materials. The volume of storage is coordinated with the volume at the butadiene plant.

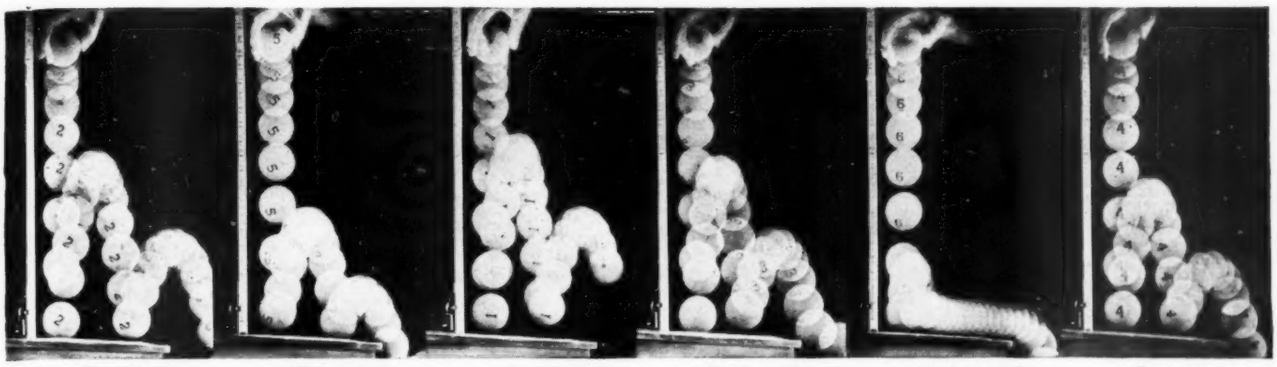
The transfer pumphouse has a plurality of pumps used for transferring butadiene, styrene, caustic soda solution, and wash water to various points of use. The butadiene pumps are piped in such a manner that material can be transferred from any one of the storage tanks to any of the other storage tanks or to a purification unit.

All tankage containing butadiene is provided with safety valves. These discharge through a collecting system of pipes into a main line that terminates in a water seal at the base of a 150-ft. stack, 18 in. in diameter. A perpetual flame burns at the top of the stack to ignite any combustible materials that may issue from safety valves throughout the plant. Inert gas is bled into this

(Continued on Page 92)



BOUNCE, BALLS, BOUNCE!



2 (Synthetic) **5** (Synthetic) **1** (Natural) **3** (Synthetic) **6** (Synthetic) **4** (Synthetic)

SIX SOLID BALLS OF RUBBER caught in the act of bouncing by a high-speed camera that shoots at the speed of 1/6592 of a second. All of them were dropped from exactly the same height...and yet, what a difference there is! One of the balls is made of a compound containing natural rubber. Each of the other five balls contains one of the five major types of synthetic rubber.

Can you pick out which of the balls is made of the rubber used in making Army barrage balloons? Which rubber is being used today for making tires for military and essential civilian cars? Which one is used for bullet-sealing gasoline hose? Which for insulating tape? Which for making lacquer hose? Try your skill. You will find the answers to these questions in the box at the bottom of this page.

SYNTHETIC RUBBER IS NOT JUST ONE NEW KIND OF RUBBER

It is a whole family of new materials each with its own important uses

Bounce the balls as much as you please. One bounces high. One bounces low. One bounces in between. Which one is best? Actually, there is no one "best kind" of rubber for every purpose. Without all of these main types of synthetic and natural rubber, it would be impossible to beat our enemies and bring our victorious men home as swiftly as possible.

The rubber industry, the chemical and petroleum industries, the Government, working as a team, have made this achievement possible. By pooling all their experience with synthetic rubber, their resources, their skill, they have broken the threat of "rubber shortage" the Axis counted on to throw us out of the war. More than that, they have produced types of synthetic rubber that can do special jobs better than they have ever been done before...and for all time declared our independence from any future cut-off of the nation's rubber supply.

That is the true meaning of the synthetic rubber program. We are proud to have contributed our experience and our resources to doing this job...and doing it in record-breaking, history-making time.

What the future holds for synthetic rubber is not yet fully known. Yet this much is certain. When the war is won, the knowledge we are gaining every day through the use of all these synthetic rubbers, alone and with natural rubber, will make peacetime products...whether tires for your car, belts for your factory, waterproof footwear for your children, or gasoline hose for your service station...better and more serviceable than they have ever been before.

THEY MAY LOOK LIKE "SIX OF A KIND" BUT HERE ARE THE ANSWERS TO THE WAR JOBS EACH ONE CAN DO

1. This ball was made with natural rubber...today used in limited quantities in combination with synthetics because of our small reserve stock.

2. Used for tires, conveyor belts, fire hose and many other products. It is most like natural rubber and can be quickly and efficiently processed.

3. Used for making solvent and lacquer hose and other products where the utmost resistance to solvents is needed...better than natural rubber for these purposes.

4. Used for making bullet-sealing fuel hose for planes and for other uses where high resistance to aromatic fuels is essential.

5. Used for coating barrage balloons, tank linings, packings, acid hose, wires and cables. This type does not support combustion and is highly resistant to sunlight and chemicals.

6. Used for insulating tape, molded parts. It is soft, pliable and odorless.

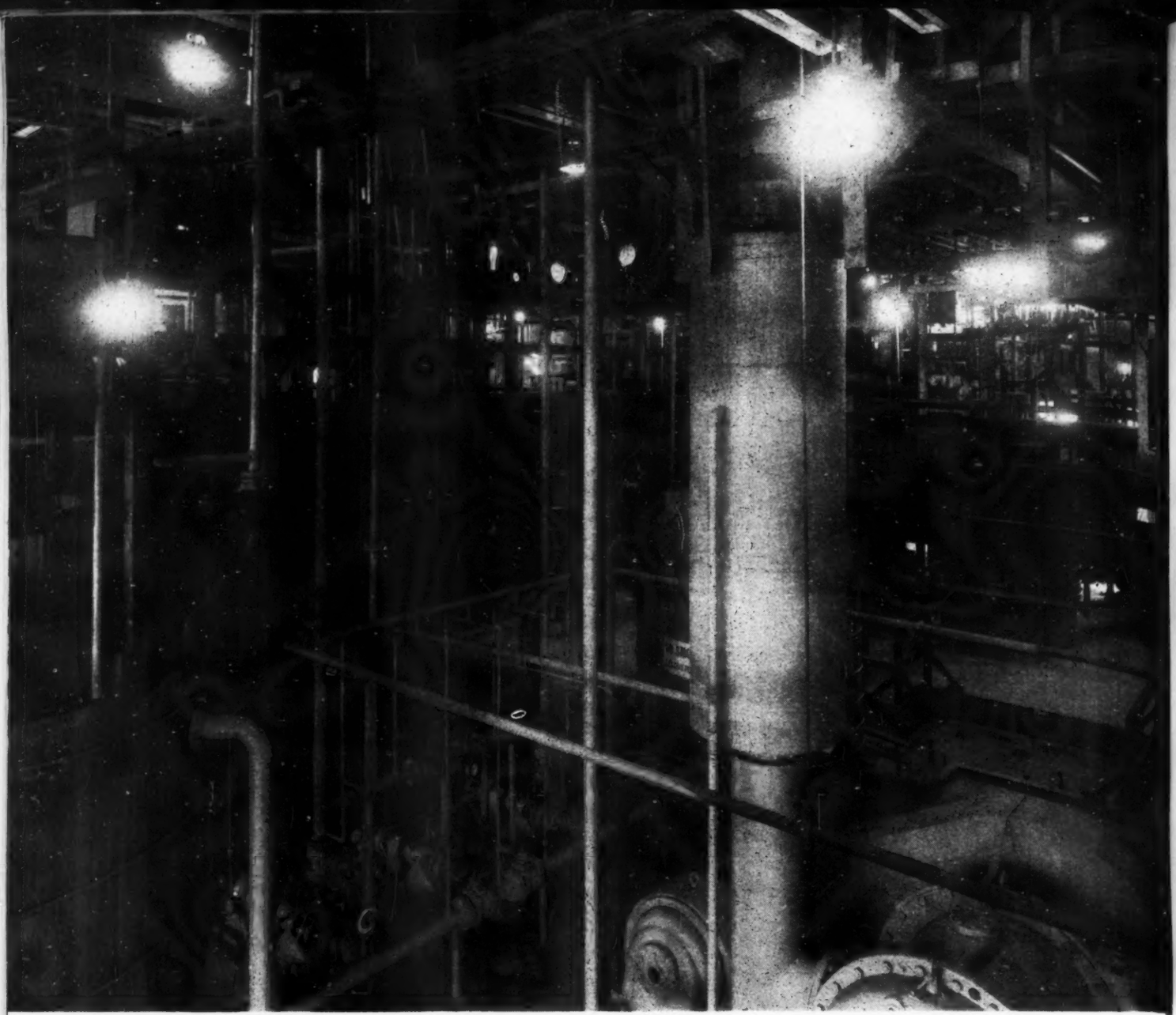
Listen to United States Rubber Company program, featuring New York-Philharmonic Symphony Orchestra, Carl Van Doren, and a guest star, broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P. M. Eastern War Time

1230 Sixth Avenue • Rockefeller Center • New York 20, N. Y.

THE NATION'S BIGGEST STOCK PILE OF RUBBER IS STILL THE RUBBER ON OUR CARS AND TRUCKS...CONSERVE YOUR TIRES!

In Canada: Dominion Rubber Company, Ltd.

UNITED STATES RUBBER COMPANY



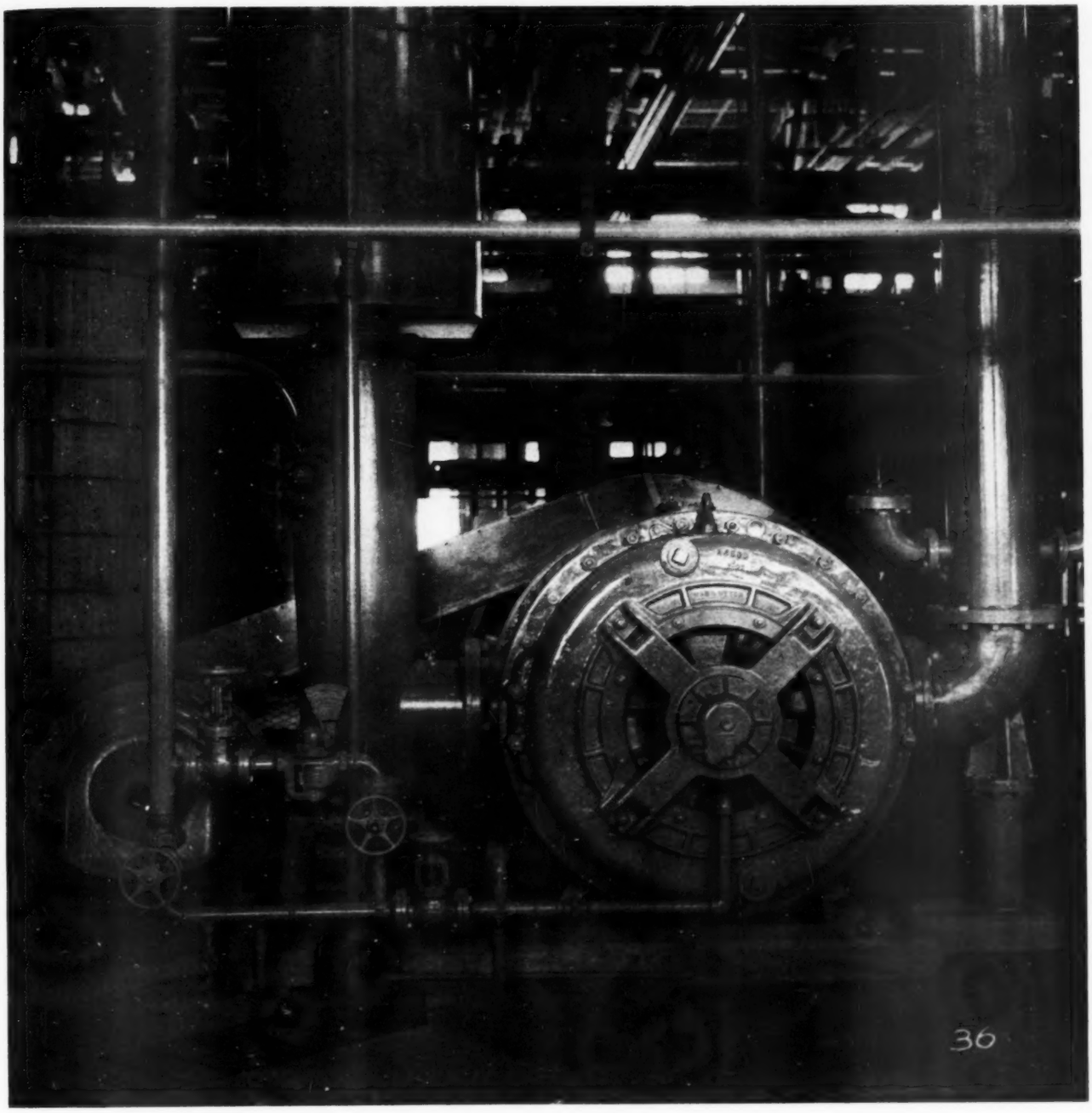
Hauser-Stander Tanks at Institute

In this maze of piping at Institute are nested a number of Wood Tanks. They are Hauser-Stander Tanks, chosen by reputation to do an important job in Synthetic Rubber, and do it well. They have many similar tanks to keep them company, and also serve efficiently through the entire cycle of operations. Similar installations of Hauser-Stander tanks serve also at Akron, Borger, Houston, Los Angeles, Louisville, Naugatuck, Port Neches and Torrance.

THE HAUSER-STANDER TANK CO.

4816 Spring Grove Avenue **CINCINNATI, OHIO**

NASH COMPRESSORS AND VACUUM PUMPS OFFER UNIQUE ADVANTAGES TO SYNTHETIC RUBBER PRODUCTION

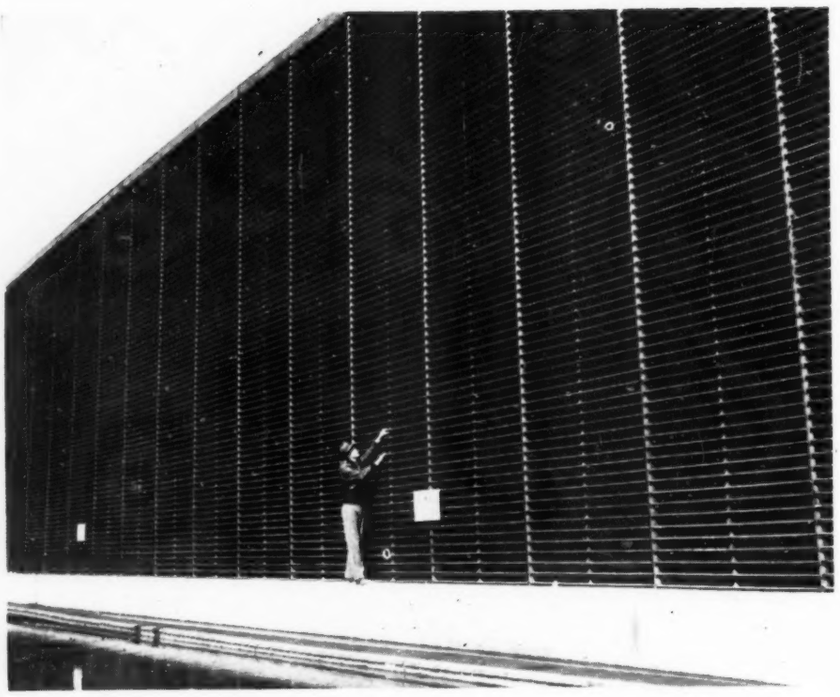


TYPICAL NASH PUMP INSTALLATION, ONE OF THIRTY AT INSTITUTE, WEST VIRGINIA

Nash Engineers have followed the synthetic rubber program closely, and Nash Pumps have found an exclusive place in synthetic rubber production. Nash Pumps have no internal lubrication, and gases such as Butadiene and Styrene can be pumped without danger of contamination. Nash Pumps will handle a liquid simultaneously with a gas being pumped. Nash Pumps permit close control of temperature of gas being handled. Nash Pumps are simple and have but a single internal moving part. There are other important advantages. Our Engineering staff is at the service of industry.

THE NASH ENGINEERING COMPANY

262 WILSON ROAD, SOUTH NORWALK, CONNECTICUT, U. S. A.



Water cooling tower. Process water is cooled at the rate of 20,000 gal. per min.

(Continued from Page 88)

collector system so that at all times the entire system will be free of air or oxygen gas to avoid the forming of explosive mixtures. The water seal at the base of the safety flare serves as a flame arrestor between the top of this device and the collector pipe.

All styrene storage in the tank farm area is vented through a separate collector line that terminates over a dyked basin with approximately 1½ times the holding capacity of the total styrene storage facilities.

The entire hydrocarbon storage is dyked and provided with fire protection equipment.

The pigment preparation area building is 100 ft. by 200 ft. in size, covering approximately ½ acre. Three million pounds of material in barrels, drums, and bags can be stored here.

Each pigment preparation building houses a large ammonia refrigeration unit.

Tankage and pumping facilities are provided for making various aqueous chemical solutions for use in the reactor area. Water solutions of emulsifier and catalyst are prepared here.

From this area, materials are trans-

(Continued on Page 96)

Left to right, top: Blow-down tanks, where polymerization reaction is stopped. A stream of coagulated synthetic rubber. Washing the flocs or crumbs of coagulated rubber. Left to right, bottom: Filter machines reduce flocs to smaller particles before drying. A loaf of buna S synthetic rubber being inspected by George A. Graham, factory manager of the plant. Triple-pass driers remove all water from rubber

THE adequate production of synthetic rubber calls for an expert balancing of military, economic and engineering considerations. Probably all of the present processes will find a place in the program that lies ahead. But, whatever the course of that program, the required results must be accomplished largely through the utilization of equipment already perfected through long use in other process industries. Time is short and the need is great.

For the pumping of liquids throughout the complete range of temperatures and viscosities, for the compression and control of gases and the creation of vacuums, for the transfer of heat, for the establishment of exact conditions of atmospheric temperature and humidity, for the generation and transmission of power . . . for all of these, Worthington equipment is now serving the gas, and many other vital industries, and will do so importantly in the new-born synthetic rubber industry as its requirements are developed.

As a result of long-range planning, much of this basic equipment is well on the way to completion, soon to take its place in the plants that are now in construction. Worthington engineering is abreast of the development in this vitally important industry. And it can be said with assurance that our research and our liaison with the industry's leaders will keep pace with the anticipated progress.

AIR AND GAS COMPRESSORS

DIESEL, GAS AND CONVERTIBLE GAS-DIESEL ENGINES

CENTRIFUGAL PUMPS

DIRECT-ACTING STEAM PUMPS

POWER PUMPS

ROTARY PUMPS

REFRIGERATION AND DEWAXING EQUIPMENT

STEAM-JET EJECTORS FOR VACUUM SERVICE

VACUUM PUMPS—R.D. TYPE

STEAM TURBINES AND TURBO-GENERATORS

HYDRAULIC DECOKING EQUIPMENT

SPEED-CHANGE GEARS

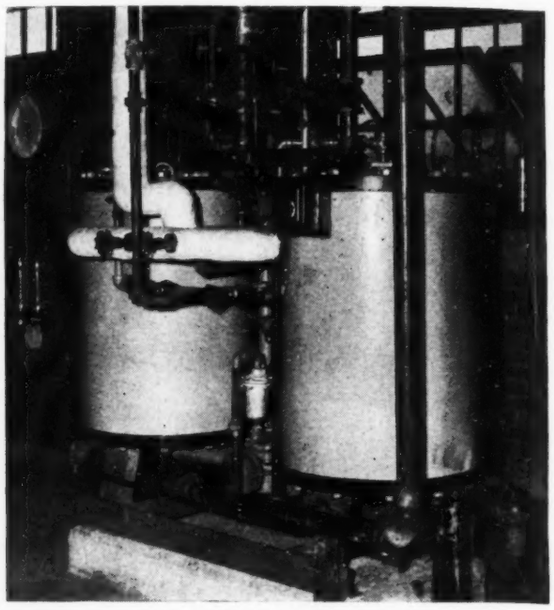
MULTI-V-BELT DRIVES

WORTHINGTON

IC3-16

WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

To be sure . . . they DRY with Lectrodryers



Air control lines in this synthetic rubber plant are kept moisture-free by Lectrodryers. This prevents the formation of rust and sludge in the lines, helping to assure reliable functioning of the controls. Higher outputs of this strategic material are, therefore, possible.

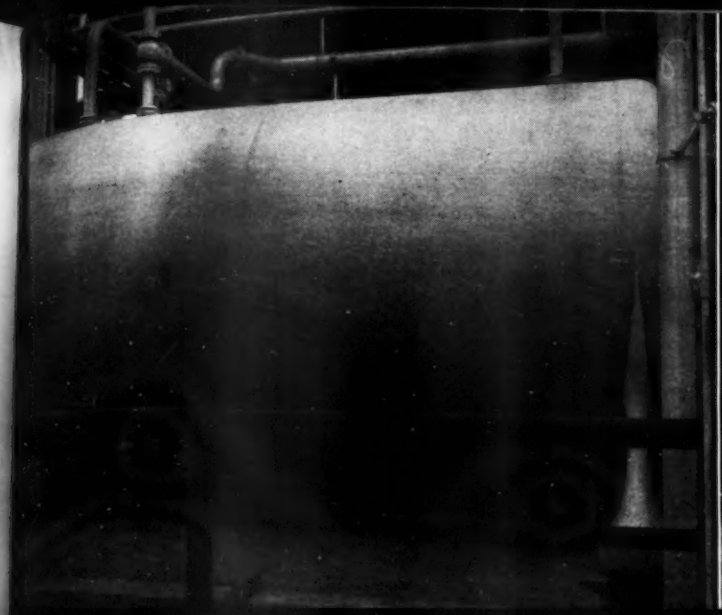
Similar DRYing jobs are being handled by Lectrodryers in many synthetic rubber and gasoline plants. In addition, they are further aiding the war effort by drying organic liquids and compounds, air and gases in other processes. They make it possible for manufacturers to work with materials of known dryness, and in controlled atmospheres, increasing their production and maintaining higher quality.

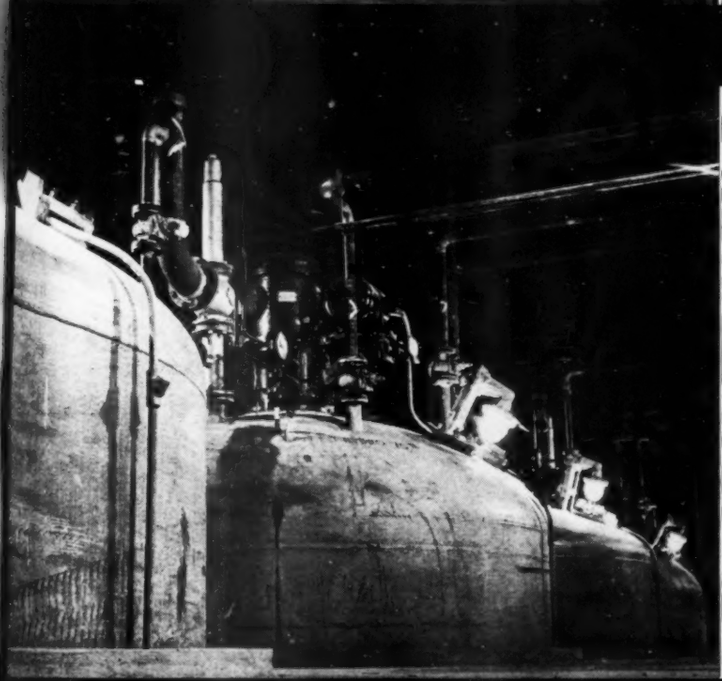
Lectrodryers, employing Activated Aluminas as their drying agent, remove every trace of moisture to dew points below −110° F. They operate at atmospheric pressures and up to 3,000 pounds per square inch. Altogether engineered for every installation, each Lectrodryer is a standard, proved design.

Why not call on Lectrodryer engineers for help on your drying problems? Write PITTSBURGH LECTRODRYER CORPORATION, 321 32nd Street, Pittsburgh, Pennsylvania.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

PITTSBURGH
LECTRODRYER
CORPORATION
Reg. U.S. Pat. Off.





GLASS-LINED STEEL
Resists Acids...Eliminates Adhesion

Chosen on its record for distinguished performance in the chemical process industries, Pfaudler glass-lined steel brings many advantages to the production of synthetic rubber.

Since Pfaudler glass is resistant to all acids (except H F) in any concentration or at any temperature, the acid conditions encountered in polymerization have no effect on the equipment.

The satin-smooth, glossy surface of Pfaudler glass eliminates adhesion during polymerization since there are no microscopic pits and furrows as truncations found even in the most highly polished metals.

Pfaudler's years of engineering-fabricating experience plus the facilities of two modern plants, enabled us to make deliveries of record amounts of this equipment "on the nose."

If acid corrosion is a problem in your plant, we suggest that you get in touch with our engineering department. Sizes, temperatures and pressures for our equipment have all been upped, making the advantages of glass-lined steel available to still more processes.

PFAUDLER GLASS-LINED STEEL EQUIPMENT USED IN THE PRODUCTION OF BUNA-S includes:

- Catalyst Weigh Tanks
- O.E.I. Weigh Tanks
- Catalyst Feed Tanks
- Catalyst Dissolving Tanks
- Jacketed Protective Agent Tanks
- Latex Flash Tanks
- Latex Vacuum Flash Tanks
- Polymerizers
- Blow-down Tanks

(Continued from Page 92)

ferred by means of pumps to the meter room in the reaction area.

The copolymerization actually takes place in the reactor area where the butadiene and styrene are emulsified in a soap solution in the presence of a catalyst. These reactors essentially are autoclaves and are equipped with a motor-driven agitator.

In order to seal the volatile butadiene against loss from stuffingboxes, a seal is used to prevent the loss of volatile material. Each reactor is provided with a pressure relief valve, discharging through a collector system of pipes to the safety flare. The agitators are of a special design that conserved a substantial amount of stainless steel. Throughout the plant, the use of special steels containing chrome, nickel, etc., has been held at an absolute minimum.

Each 30,000-ton line is equipped with an interlocked double set of meters for the preparation of a reaction batch. The necessary materials for a reaction batch are pumped in from the hydrocarbon surge tank and the pigment preparation building through preset meters and Merco Nordstrom valves that discharge directly to the reactors. Some of the ingredients of the reactor batch are weighed out on a scale and then transferred by means of pumps to the reactors.

The conditions of reaction are controlled by means of a group of temperature and pressure recording controlling devices. The control room and meter room are held under a small positive air pressure as a safety measure, as instruments of the type used are not sparkproof.

A large vessel is provided to function as a holding tank between the reaction step and hydrocarbon recovery operations.

One latex tank is provided for each group of reactors for material that may require special handling.

Each group of reactors is also provided with a tank that is situated between the collector system of the safety relief valves and the safety flare. This is simply an emergency proposition to prevent large amounts of soapy, foamy reaction mixture from entering the safety flare lines.

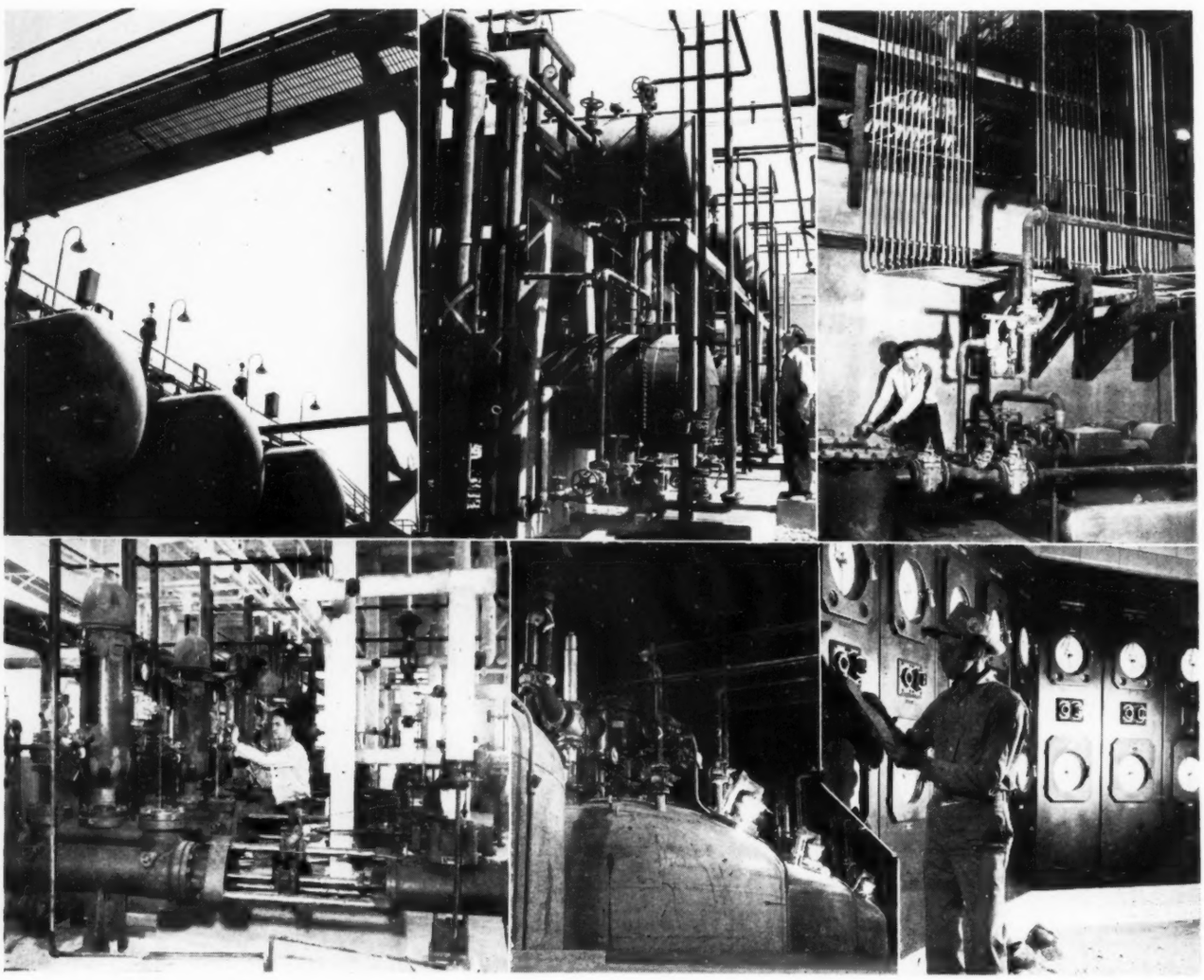
After the completion of a reaction, the material discharged to the blowdown tanks consists of latex or liquid rubber, unreacted butadiene, unreacted styrene, soap solution, and catalyst.

Large vats are provided for latex storage in the plant.

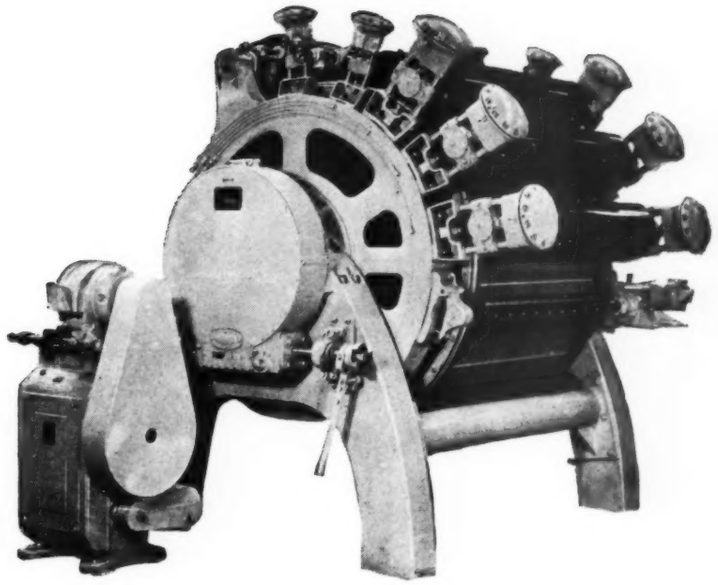
Feed pumps transfer the material from the blending tanks to vessels where coagulation of the latex takes place. After coagulation, which changes the latex from a liquid to small particles,

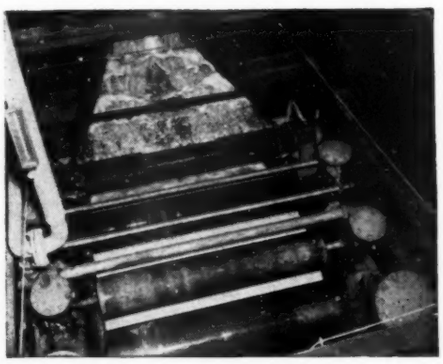
(Continued on Page 100B)

Left to right, top: Butadiene and styrene storage. Purifying butadiene by removal of inhibitor. Blending batches of latex to assure uniformity of product. Left to right, bottom: Transfer pumphouse — butadiene, styrene, and other chemicals are moved by pumps. Glass-lined reactors for polymerization. Progress of polymerization is recorded and controlled by operator in control room



This Oliver Filter was designed and manufactured especially for the Synthetic Rubber Program. An operating unit is shown below.





Special type

OLIVER FILTER

designed for the production of

SYNTHETIC RUBBER

Here's the result of a typical Oliver United pioneering job . . . the result of the company's long standing policy of investigating new fields and products in the interest of applying efficient dewatering and washing equipment to processing.

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The performance of this Oliver Filter in the Synthetic Rubber Program has exceeded even the high estimates of capacity and washing efficiency that our experience indicated could be obtained.

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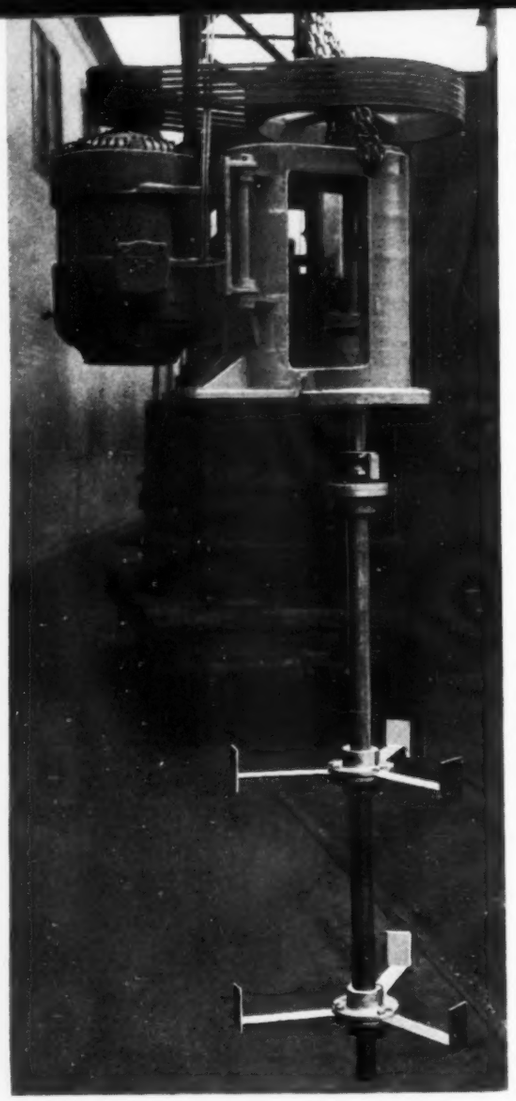
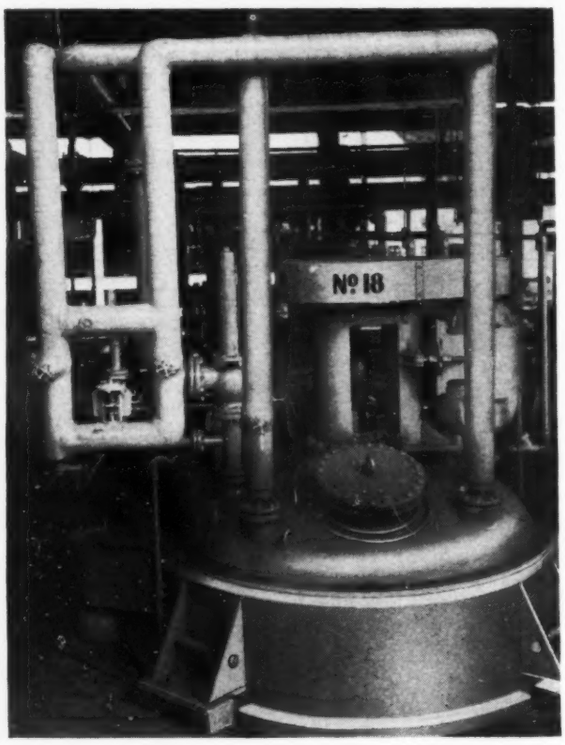


STRUTHERS WELLS Radial Propeller Agitators were used in the first pilot plant for synthetic rubber and have continued to be used in the subsequent commercial installations.



Copolymer Reactor for one of the synthetic plants showing Struthers Wells Agitator.

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STRUTHERS WELLS Agitators

The Struthers Wells Radial Type Propeller introduces a new principle of agitation. This agitator consists simply of hub, supporting arms and agitating blades. The agitating blade is usually parallel to the shaft, and is pitched a few degrees from a right angle to the center line of supporting arm, thereby forcing the agitated liquids radially outward. The degree of pitch is determined by the type of agitation required. If severe cutting action is an essential factor, the degree of pitch is small, allowing extremely high peripheral blade speed. If movement of the agitated liquids is required with a minimum of turbulence, the degree of pitch is increased and peripheral blade speed decreased. The fact,—that having fixed the RPM of the Struthers Wells Radial propeller, the degree and type of agitation can be quickly and inexpensively adjusted by simply changing the length of the supporting arm and proportioning the pitch of the agitating blade,—was an important consideration in the selection of this agitator for the Copolymer Reactors.

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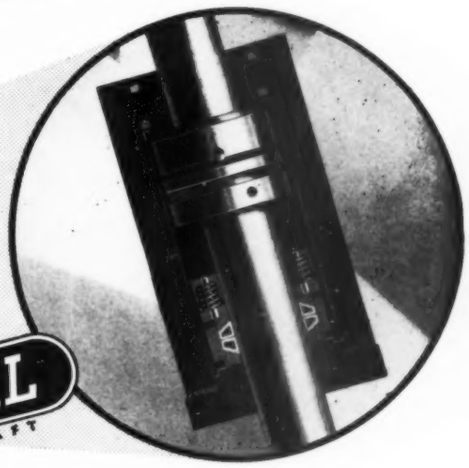

A MECHANICAL SEAL solves a difficult problem in the production of synthetic rubber ....

DURA SEAL — The PERFECT SEAL TRADE MARK

ROTATES WITH THE SHAFT

Photo Courtesy Patterson Foundry & Machine Company, East Liverpool, Ohio.

Over four years ago Durametallic Engineers were working with leading rubber manufacturers toward solving the sealing problems of synthetic rubber solutions. An outstanding accomplishment is illustrated above where Durametallic Double Dura Seals are sealing agitator shafts on reacter vessels. Investigate Dura Seal if you have difficulties in sealing volatile, corrosive or gritty fluids at high or low pressures, temperatures and RPMs.

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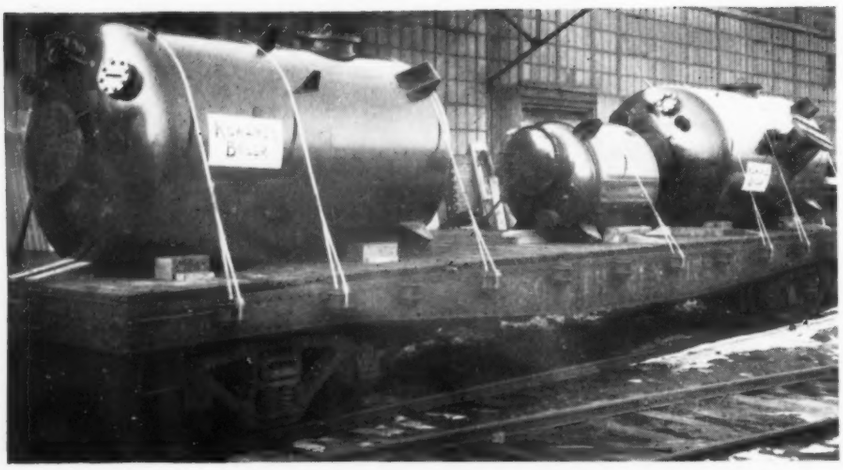

Tanks for process chemicals being shipped to institute plant

(Continued from Page 96)

the material is pumped to the rubber finishing area where the now solidified rubber is separated from the inorganic constituents by mechanical means.

The coagulated material is filtered on a large rotary vacuum filter. A vacuum is maintained on the filter drum by means of large pumps.

The material is dried in large air driers. The product is fed progressively through the system for complete drying.

The dry material is fed to an automatic weighing machine that delivers 75 lb. of material to the baler in one portion.

The 75 lb. of dry, shredded material are delivered to a fully automatic baler. In this operation, the material is compressed into a rectangular block.

A total of 16,000 sq. ft. (200 ft. by 80 ft.) of finished rubber storage is provided. Three million lb. of rubber can be stored in this area when piled approximately 4 ft. high. At present the synthetic rubber is being shipped to the manufacturers of rubber goods.

Two laboratories are provided in the plant.

The field laboratory and main laboratory are interconnected. When fully staffed, a total of 100 chemists and analysts will be employed for the control of the technical phases of the work.

Technical Personnel

Approximately 50 percent of the technical personnel will be women. At the present time the female staff consists of one graduate chemist, five college graduates with some chemical training who are functioning as technical clerks, twenty high school junior analysts, and eight high school physical rubber testers.

At full plant capacity there will be a total of 50 girl analysts.

Critical Stock Conserved

In the construction of the Institute synthetic rubber plant, critical steel was conserved insofar as was possible. Reinforced concrete is used in the many structures, as well as wooden roof trusses, tanks, and railings.

Future of Synthetic Rubber

So many factors enter into the future of synthetic rubber production in the United States that it is difficult to estimate its post-war importance. Men in the rubber industry, however, are quite agreed that it will have an important part to play and that it will not disappear with the recovery of natural rubber producing areas from our enemies.

Although many technical difficulties have been encountered in processing synthetic rubbers for tires and other products, these are being overcome. The first synthetic rubber tires were of poor quality, but good quality tires now are being made.

Just how far improvement in the quality of products can go is uncertain at present. Some rubber men are of the opinion that, given enough time, synthetic rubber may overreach natural rubber for most purposes. From the viewpoint of the future of synthetic rubber, our government must decide what stand it will take to protect itself against the loss of its normal supply of natural rubber in any possible future emergency and must appreciate the efforts of other countries to preserve their markets for natural rubber.

For the photographs used to illustrate this article we are indebted to Blaw-Knox Company, Carbide and Carbon Chemicals Corporation, United States Rubber Company, and Kewanee Boiler Corporation.

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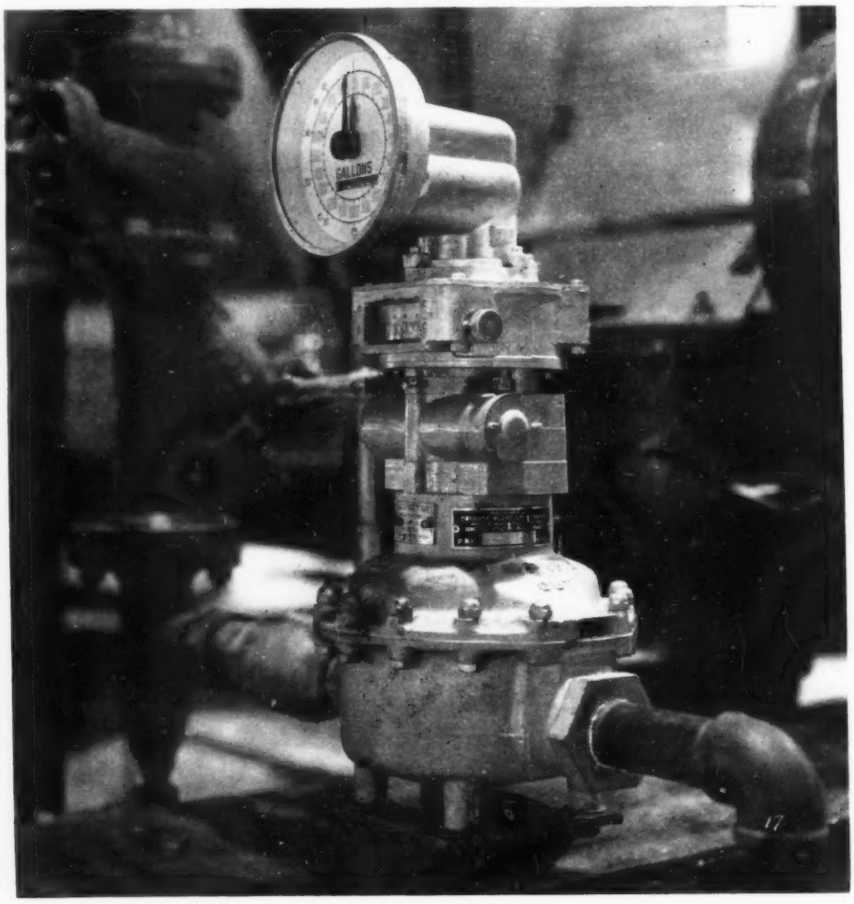

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Interior view of oil heater combustion chamber with B&W Tubes disposed over ceiling and side walls.

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B&W seamless and welded tubes are used extensively throughout refinery and similar processing industries for practically every form of heat-transfer service. Such applications may range from sub-zero temperatures, where high-impact strength at such temperatures is the prime requisite, to services involving temperature up to 1500 F. accompanied with pressures up to 4500 pounds per square inch.

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Casing Salvage Aids Steel Conservation

PETROLEUM ENGINEER Exclusive Feature

☆ Casing recovered from producing wells for use in new wells

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

CONSIDERABLE difference exists between salvaging casing pulled from a well during repair and abandonment operation and the deliberate entry of a producing well for the sole purpose of recovering casing for use in other wells. It has been desirable or necessary during past years to pull much casing during repair work. The chief motives then were, first, to get the string out of the way and, second, to obtain salvage. The condition of the pipe, threads, and couplings were incidental. With the shortages that now exist in the oil industry, however, second-hand casing is a valuable item and when a well can be produced as efficiently without a string of casing, that string, or the greater part of it, may aid considerably in maintaining the drilling program of a company. This has resulted in the recovery of many tons of casing in the oil fields of California during the last year and the saving of a considerable amount of new steel. In removing the casing particular attention has been paid to the condition of the pipe, threads, and collars.

Most of the casing being recovered consists of that part of full oil strings above perforations. The general practice is to cut the strings above the shoe of the water string and leave the perforated section in the well to serve as a liner. The cut must, of course, be made above the free point and when this is below the shoe of the water string the amount of lap left in the water string varies both with the conditions encountered and with the opinion of the operator.

The pipe recovered is, of course, second-hand casing and the operators are aware that such casing, properly selected, will be fully adequate for the purpose to which it is to be used. In California there are a number of shallow fields being drilled as rapidly as possible and the second-hand casing taken from other wells has been a definite factor in the rapid development of these fields. Several of the large companies have been very successful in their casing recovery programs and through their experience have established techniques that fully take into account the protection of the producing wells from which the casing is taken, the condition of the strings removed, and the selection of pipe and couplings for use in other wells.

Preliminary Data

The recovery of casing involves much more than just going into a well, cutting and pulling the pipe and then shipping it to some drilling well for use. If a sufficient amount of the casing to be pulled is not going to meet the requirements for use it is better left where it is; and if the condition of the well is such that the removal of the pipe is even remotely likely to cause the loss of a producing well, no matter how small the well, it is poor economics to take the casing out of the hole. The drilling records should be examined in detail and the subsequent production history carefully studied. Most of the wells from which casing is to be pulled are old wells and the histories will probably be so incomplete that no available information should be overlooked.

Seamless casing did not come into general use until about 1925 and most company records lack data on the type of casing, its weight, make, etc., in the wells from which pipe is to be recovered. The condition of the oil string to be pulled and that of the water string through which it was run are important factors and one company asks the following questions regarding these two strings before going into a well to pull any pipe:

1. How long was the oil string worked through and was the work done with rotary or cable tools?
2. Have there been any bailing jobs since the well was completed? If there have been many bailing jobs, the recoverable string may be badly line cut, especially in wells of low fluid level.
3. Have tubing jobs shown bad collar wear? If the collars wear badly, the oil string may be worn badly unless collar positions have been changed.
4. Have there been any cement jobs since the oil string was landed that might have cemented it in place above the perforations?
5. Are there any clues to bad casing, bailers hanging up, etc.?
6. How long was the water-shut-off string drilled through?
7. Were rubber protectors used in drilling through the water string? (These did not come into general use until about 1929.)
8. Any other clues to a bad water string, swagging, etc.?
9. Are there indications of crooked hole? Crooked hole may explain many twist-offs, casing pulling hard, necessity for high torque to cut casing, etc.

It must, of course, first be determined whether the casing, or a sufficient amount of the string to make the operation worthwhile, can be pulled without damage to the well. Some companies then run an instrument[1] to aid in determining whether the pipe is desirable. The instrument also gives depths of the collars and thus aids in determining where to cut the pipe. Before running an instrument into the well a feeler or impression block is run, or some other method used, to make sure the instrument will go down easily. Assuming 6⅝ in. casing is being pulled, the average weight of this size pipe is 26 lb. and it has a wall thickness of 0.385 in. or a little over ⅜ in. If the Dia-Loy is used, the gauge for the first run is set at ¼ in. wall thickness. If the results of this run indicate that there are many extra good joints that can be used in deeper wells, the gauge is set for 5/16 in. and a second run made. In most cases the casing has been found to be less than ¼ in. thick and the gauge for the second run is set for 3/16 in.

Cutting Point

In wells where the pipe to be recovered is part of an oil string that has not been cemented and the annulus is not full of fluid, assurance that the string is free to the top of the producing zone is sometimes made by putting approximately a pint of fluorescein dye, fol-

[1]The Dia-Loy instrument is sometimes run in the well before the casing is cut. The Tuboscope is also used to check joints of casing after they have been pulled to make sure they are suitable for some particular application. Both instruments have been described in a paper entitled "Recently Developed Methods for the Inspection of Tubular Goods and Sucker Rods," by H. M. Henderson, presented at the Spring Meeting of the A.P.I., Division of Production, in Los Angeles, March 11, 1941.

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This Tool Department prevented a "bottle-neck" in tooling up the Hughes Main Plant, Aircraft Strut Division, and Dickson Gun Plant and helped to speed production for war . . . and it continues working 'round the clock to fur-nish the tools which maintain Hughes Quality in the production of airplane landing gear and propeller ferrules; gun barrels; brake drums and transmission parts for tanks; stuffing tube bodies and many other parts for ships . . . *these in addition to tools for the essential oil well Drilling Industry.*

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lowed by 20 bbl. of water, down the outside of the casing while the well is still pumping prior to the salvage operations. Samples of production are then taken every four hours until the dye shows up. Any other dye that will meet the requirements can, of course, be used. The quantities of dye and water will vary in accordance with the amount of fluid the well is producing, the fluid level, etc., but it has been found that a pint works satisfactorily with wells making up to 50 bbl. per day gross. It is believed that this amount will be sufficient up to 100 bbl. per day and that larger wells will simply require larger quantities of dye.

If the casing has been cemented, if fluid lies behind the string to be pulled, or if the dye does not show up it is necessary to determine the free point. Several methods have been used for this purpose, the various companies employing different procedures. Among these are rule-of-thumb estimates, the employment of casing pulling charts based on the modulus of elasticity modified to allow for indeterminate factors such as friction and buoyancy, calculation made from pressure when hydraulic jacks are used for pulling casing, and the stretch method based on elongation measurements. It is the policy of one company, when the oil string has a full column of fluid between the oil string and the water string, to leave the well alone (at least for the time being) or to study the history more carefully before attempting to pull any casing. When it has been determined where the casing is free, it is generally deemed advisable to cut a little higher and be sure the string is loose above the point and thus avoid the hazard of leaving some loose nipples that may later work loose and interfere with production.

The stretch method is being used by several companies and is said by some engineers to determine the free point within 50 ft. This degree of accuracy, however, is not relied on by most companies using the method and the cut is generally made 100 or 200 ft. above the point indicated. The formula is:

$$\frac{l}{L} = \frac{s}{S}$$

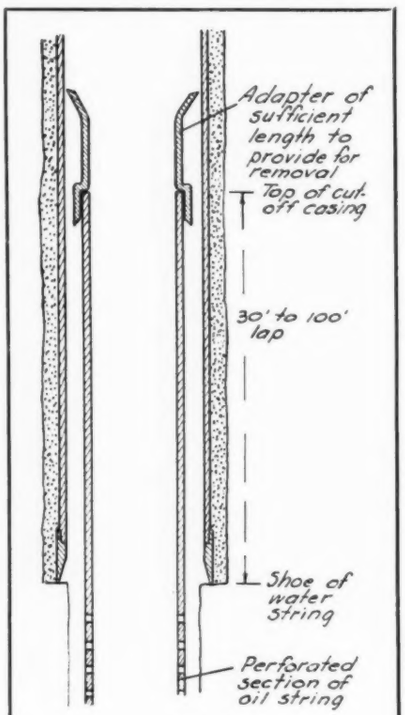
Where:

l = the length of the top joint,
L = the length of the free portion of the string,
s = the stretch of the top joint, and
S = the stretch of the free portion of the string.

To obtain the measurements for use in the formula a joint of casing of same size and weight as that composing the string is attached to the top of the string and a strain applied. The total amount of stretch and the amount of stretch of the top joint are measured. These, with the known length of the top joint, supply three quantities for the formula. The stretch of the top joint is measured by attaching a dial to the bottom of the joint and a rod to the top of the joint, the rod actuating the dial as it moves upward when the stretch is applied. It has been found by tests that the grade of casing used for the top joint has no effect on the measurements of stretch. A lap weld joint was first used in making one test and this was then replaced with seamless J-55, both joints being the same weight and the same as that of the string to be pulled. The measurements, read in thousandths, were the same.

Cutting and Pulling

A great many producing wells from which casing has been recovered in California have been equipped with production derricks. Most of the derricks are of the standard 122 ft. type and a two-drum hoist is generally moved in to conduct the operations. When derricks are not in place, hydraulic jacks are widely used for raising the pipe and either portable rigs with collapsible derricks or hoists with gin poles or A-frames are used to handle the casing.


Adapter of sufficient length to provide for removal
Top of cut-off casing
30' to 100' lap
Shoe of water string
Perforated section of oil string
Fig. 1

The cutting procedure followed by one company is to free the casing from the landing head and take a strain on the casing of between 1½ to 2 times the original weight of the string. That is, if 4000 ft. of 6⅝ in., 26 lb. casing weighs 52 tons, a pull of 75 to 90 tons is taken. The joint strength of this casing when new is 111 tons but a deduction of about 25 percent is made to allow for wear and poor collars. The tubing and cutting tools are then measured in, in tension, to the desired cutting place, usually 7 ft. above the collar of the first blank joint above the perforations and above the shoe of the water string. The reason for the 7 ft. stub is to allow the collar below the cut to center the casing for the casing bowl of the liner hanger, which this company sets after the pipe is pulled. This also provides room for a second cut if it is necessary.

This company uses a cutter that makes a beveled cut so that, in case the liner hanger and adapter will not go down the hole, the bevel will act as an adapter and reduce the chances of the bailers hanging up. In two cases it was impossible to run the adapter-hanger and it was necessary to leave the cut as it was made. In neither case has any trouble yet been experienced although it is still felt desirable to do a complete job and set adapter-hanger if possible.

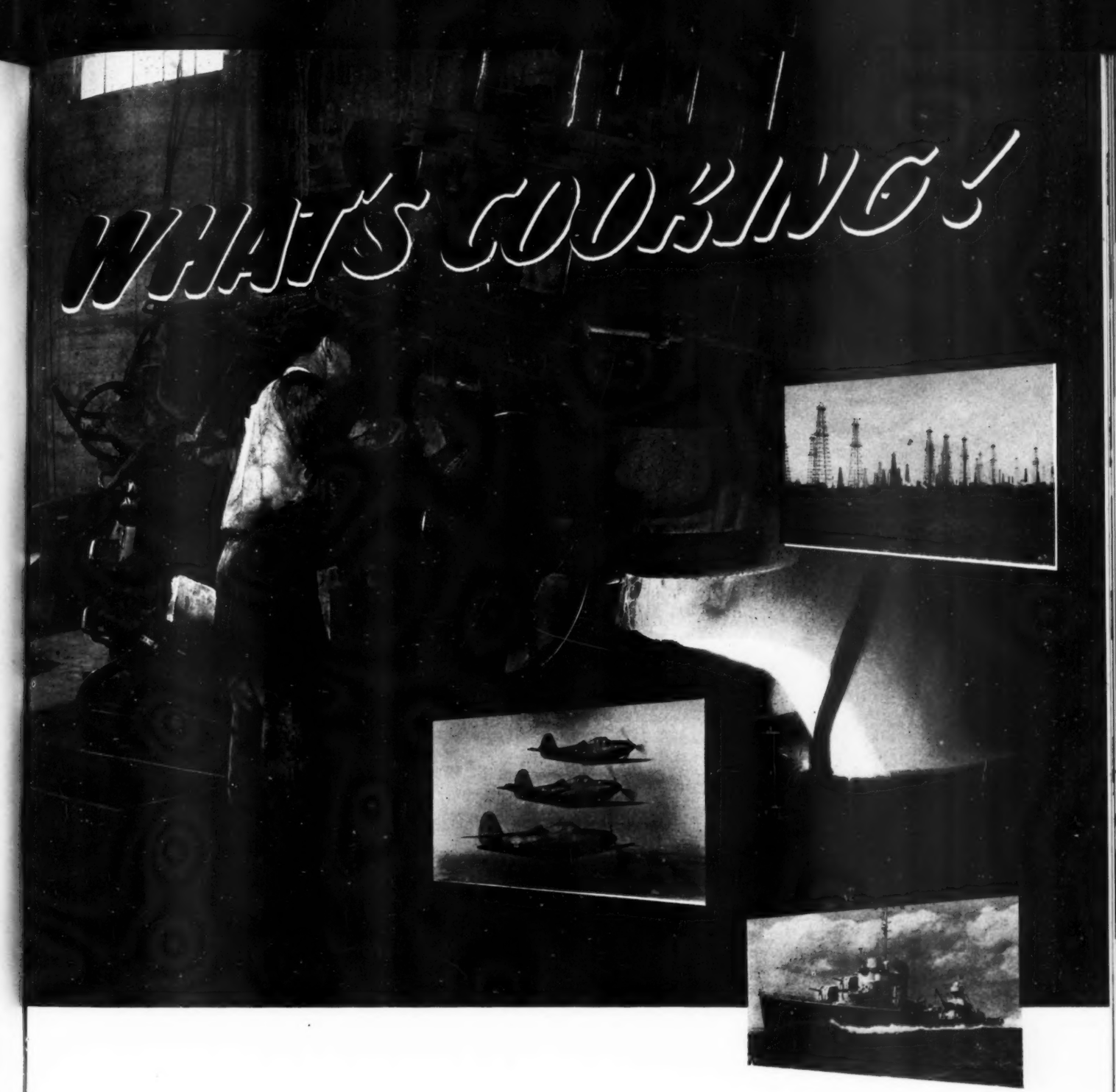
Various means of cutting pipe by using tubing have been tried by this company. The setting of a rotary table has the disadvantage of necessitating the moving of the tubing upward or downward while rotating; power tongs were not found satisfactory; hand tongs and manpower are slow and very objectionable from the crew's standpoint. The method finally adopted was the use of an empty casing spool cut down to make a pulley with approximately 6 in. between flanges. This is clamped to the tubing with tongs and U-bolt and an endless rope run to the cathead of the hoist. The cutting proceeds until the casing jumps free or until everyone is satisfied the knives are not working.

Some companies have cut the casing with tongs and manpower. Others use the rotary attachment when portable drawworks so equipped are employed. One company employs a small rotary table driven by a motor of low horsepower. There are various methods of collar shooting, and collar shooting and belling the collar as an adapter, but shooting has not been favored by operators in California.

The use of a conventional liner hanger and adapter prevents any slippage of the casing left in the well as a liner. One company, however, is making adapters of general design as shown in Fig. 1, which have proved satisfactory for shallow wells. The actual device constructed varies with different conditions and may be made from whatever material is available.

The pipe is pulled in doubles or singles. In many cases the doubles have formed such dog legs that they have been hard to handle. Some companies therefore favor pulling all singles. Many of the threads and collars have been found to be badly galled, and, although

WHAT'S COOKING!



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this would be considered incidental in normal times, the shortage of collars now makes it a matter of importance. The problem was put up to the research department of one company and this department came through with some thread-loosening oil. In applying this dope, the recess of the collar is thoroughly cleaned and a jet from a gas line, if available, is used to help in the cleaning process. A slight amount of hammering on the collar with two-pound hammers, often done while a little strain is on the breaking tongs, sometimes helps without doing much harm, particularly if the joint is breaking hard. Sufficient time is allowed to let the dope work down. The result has been a decided improvement and the sharp edges of V-threads seem to be left on the doped joints whereas these edges are rounded off on the undoped ones. Most of the casing being recovered by this company is in 22 ft. lengths and is laid down in doubles to save alternate joints.

Testing Pipe and Threads

After the casing is out of the hole the joints are classified for use. It has been found during the last year that the overall average of usable casing recovered by all companies has approximated 60 percent. Moreover, each of the larger companies that has gone into this recovery work extensively has found the individual company average to be about this same figure. The worst recovery from a single string pulled has been about 40 percent junk and the best has been 100 percent.

The opinion of some engineers is that the Dia-Loy run in the well should be considered as a preliminary check to determine whether an attempt should be made to recover the casing. It has been found that the ratings made by the instrument are usually pessimistic, the wall thicknesses in all cases checked being appreciably greater than indicated. The presence of long worn spots is clearly shown by the curves but short, slight pits give indications that are misleading.

The practice of one company has been to inspect the casing as it is being laid down in order to save handling. This inspection is visual and is made by someone experienced in the work. In many cases some of the pipe is immediately routed to the well in which it is to be used and only the joints requiring repair work are sent to the shop. Although inspection is based on modified A.P.I. standards for wall thickness and threads, the casing is not repaired because it will not meet A.P.I. specifications for thread accuracy. Much of the casing was made before there were any A.P.I. standards. The check made is one that will insure that the joints will make up and match in their various elements. Damaged casing and threads are repaired when feasible. The pipe can, of course, easily be rethreaded and even poor coupling threads can often be put into satisfactory condition. When 20 ft. lengths are pulled they are generally welded into 40 ft. pieces to save the number of collars necessary for running the string.

One company that has recovered a considerable amount of lap welded casing feels it necessary to pressure-test all joints of this kind. A hand-operated test pump is used for the purpose and the pressure is built up to 1000 lb. per sq. in. Of 800 to 900 joints thus tested, only five failed at pressures ranging from 250 to 1000 lb. per sq. in. The Tuboscope is used by this company only to check seamless casing that is to be used in comparatively deep holes, one string of 5¾ in. recovered casing being run to 8000 ft.

Utilization of Casing

The setting depths for second-hand casing pulled from producing wells are based in general on the wall thickness as determined by measurements and on the grade of the casing. In some cases where the demand has been urgent the pipe selected as usable has been assumed to meet the requirements and has been run to the depths from which it was recovered.

The usual practice has been to run second-hand lap weld casing as water strings to depths up to 2000 ft. The 8⅝ in. and 9 in. seamless pipe has been used for water strings between 2000 and 3000 ft. and the 6⅝ in. as liners in wells up to 4000 ft. The 5¾ in. has been used for water strings in deeper wells and for liners.

The unusable casing is classified as junk but much of it is laid as line pipe where little or no pressure will be applied. Probably more than 80 percent of the pipe classified as junk is used for this purpose and has in itself aided materially in lease operations during this period of metal shortage. The remainder is actually junk and usually goes to the salvage department for whatever use can be made of it.

A Specific Program

One company surveyed the possibilities of recovering casing in the fall of 1941; in 1942 it revised its estimates and intensified its program. An examination of well records and logs revealed that it had an underground warehouse of approximately 1,150,000 ft. of casing of various sizes, the equivalent of 16,000 tons of pipe. This pipe could all be pulled without injuring the productive capacity of the wells as the casing had been installed under the earlier California practice of running full oil strings for production instead of placing liners or gun-perforating the casing in the well.

During 1942 approximately 150,000 ft. of casing was pulled and about 45,000 ft. used in other wells. The remainder was sold as second-hand pipe or used as line pipe, approximately 18,000 ft. being laid for a gas line. In the first six months of 1943 more than 100,000 ft. of casing was pulled and about half of that was rerun. The quality of the pipe recovered is shown by the following percentages:

Used as recovered	63.5 percent
Needing repairs before using (usually new threads and/or collars)	26.0 percent
Junk or line pipe	10.5 percent

The rejected 10.5 percent of the pipe was placed in three classes:

Internal defects, line cuts, corrosion, etc.	2.5 percent
External defects, corrosion, pits, tong marks	2.4 percent
Other defects	5.6 percent
Total rejects	10.5 percent

Most of the 2.5 percent thrown out because of internal defects was rejected by Tuboscope inspection. Poor threads constituted the largest part of the rejected pipe. In classifying the casing, A.P.I. thread specifications were expanded, as rerun threads cannot be expected to be up to standard. Because most of the pipe was used in holes 3000 ft. or less in depth the lower specifications have caused no trouble.

The wall thickness requirements also were lowered. For example, if 22 lb. casing would be sufficient for the well, thin-walled 26 lb. pipe that had a thickness equivalent to that of 22 lb. could be used. The wall thicknesses were "tailored" to the job.

The external inspection looked for crooked joints, crushed places, slip or tong marks, pits, corrosion, and bad threads. Internal examination was for line cuts, perforator indentations (when the perforator failed to work), weak seams, mill imperfections and other weak spots as disclosed by the Tuboscope. Threads and collars were inspected optically and by gauges.

Very little trouble was encountered by this company after the first objections to the use of second-hand pipe were overcome. The field forces and the crews have done good work in running, setting, and cementing the strings.

Editor's Note: This article is based on material presented by W. H. Farrand of The Texas Company, Henry Winter of Union Oil Company, and John Hills of General Petroleum Corporation at an open meeting of the Topical Committee on Drilling Practice of the A.P.I. held in Los Angeles.

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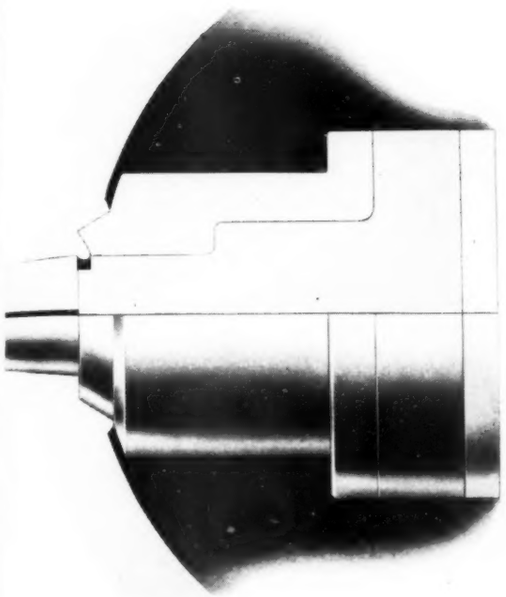

TAPER OF INSERT AND CRIMPING PROVIDES POSITIVE LOCK

This quarter section drawing shows the insert being thrust through the tubing wall. It illustrates the taper that, combined with the crimping, locks the insert securely in place in the tubing wall.

The OTIS Wire Line Tubing Perforator is a mechanical tool run into the tubing under pressure on an ordinary steel measuring line. By manipulating the wire line, the removable stop on the lower end of the perforator can be set at the desired depth, thereby permitting perforations to be made anywhere in the tubing string. The stop serves as a base for the perforator to work against.

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GENERAL PERFORATING PRACTICE

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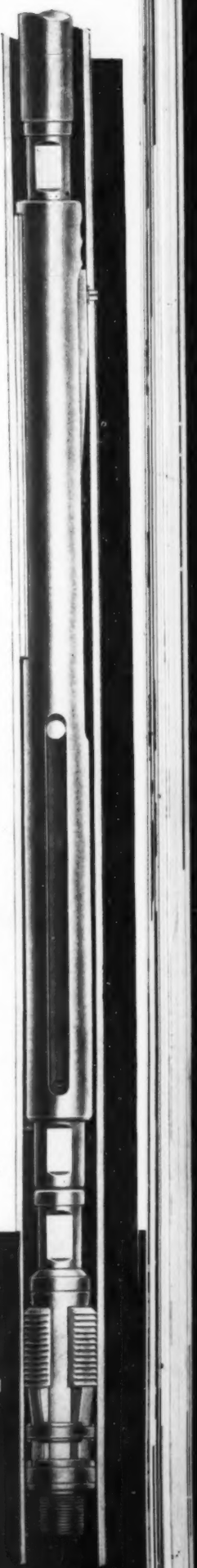

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DALLAS, TEXAS

Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Manufacture of Lubricating Oils

Class Meeting No.11 (Continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

Pupil: What about time—does time have any effect on the melting point?

Pupil: I think not. That explains some of the jell formations, as it is found that when you are "cooking" the grease out hot you get good solution and when it cools down you have super-saturation and jell formation at that point. All greases are not of that nature but some of them are—possibly dehydrated sodium soaps are products of that nature. One writer goes into this rather deeply. He discusses a number of theories regarding the colloidal structure of grease, but doesn't go into any of them deeply enough. I will give you my version. The writer mentioned speaks a great deal about liquid crystals and their effect on the texture and appearance of greases. These liquid crystals are nothing more than large clusters of molecules that do not have any definite form. The axes of molecules are not definitely arranged so there is no definite crystalline structure; nevertheless, they have forms similar to solid crystals. In the preparation of calcium soap the presence of water is necessary and it is necessary in the preparation of sodium soap also because there is no such thing as dehydrated sodium soap. It may be dehydrated to the point that no distillation can be found by analysis, but there is still some in it. The statement is made that the phases are oil in water or water in oil, depending on the solubility of the soap—if the soap is more soluble in oil than it is in water, which is the case in calcium soap, then you will have the soap going into the oil and reducing the surface tension and allowing the oil to envelope the water, whereas with the alkali soaps you have much more solubility in water and the surface tension of the water will be reduced and you will have the soap and water phase externally, and if any of you have observed alkali soap, you will see that is true. It is very readily attacked by water. You have the soap and water in the external phase. Bhatnagar gives an explanation of it in another way. He says if the soap contains negative ions it is wetted by water and will form oil in water emulsions, but if it contains excessive positive ions, it will be wetted by mineral oil. Calcium soap contains excess of positive ions and is wetted by water. I don't think there is any scientific basis for this argument. There is also another theory here, on molecular structure—you have a long string of carbon atoms and sodium out here and of course, you will have an OH on the end there, and you have a string of these, and the theory is that your string begins to bulge here and this would be the external phase then, sodium and hydroxide, and you will have the hydrocarbon on the inside and this material here is wetted more easily by water, and the water will be in the external phase. Calcium soap is just the opposite. You have to have two-string hydrocarbons to unite with one calcium. We do know that with calcium soap we have oil in the external phase and with sodium soap we have water in the external phase. To give you some idea of the complexity of lubricating greases, the oil phase itself is complex. We have aromatics, nitrogens, and sulphur each having an effect on the jell formation, the colloidal structure of grease, and whether an oil is olefinic or naphthenic does make considerable difference in its adaptability to lubricating grease with regard to yield, etc.; in fact, Klemgard brings out the fact that there is a great need for study along that line regarding the effect or nature of the oil on yields and other properties of the greases and I think we have already learned that here. The soap phase is quite a complicated phase. Clemgard lists seven different metals that are used; however, the principal ones are listed. You have saturated and unsaturated fats and fatty acids varying from 8 to 20 carbon atoms. You could not make a grease very well with a fat having 20 carbon atoms in it, or one with 8 carbon atoms. Klemgard states that fats or fatty acids having less than eight carbon atoms are unsatisfactory for grease manufacture. In our experience you could not expect a good yield with anything under 15 carbon atoms. I want to read a statement he made here:

The colloidal properties of the salts of the fatty acids decrease with molecular weight. Highly unsaturated fats give low yield values in most cases.

They had to study lubricating greases to add to their knowledge of colloids and we tried to apply some of the simple colloidal principles to lubricating greases. Nearly all of these theories I have mentioned have been based on some simple study such as soap and water. I am not going to make any statement regarding the colloidal properties of mineral oil itself other than it definitely exhibits Brownian movement, which puts it in a class of at least some type of colloidal substance. Regarding colloidal properties of the soap phase, McBain states that soda soaps have five distinct forms, two types of liquid crystals, and two solid crystals and the fifth is solution. As I stated before, sodium soap is always associated with greater or lesser quantities of water and the completely dehydrated form is not used in lubricating grease at all. Clemgard has done some work on studying the structure of greases by the use of a microscope. In studying greases, he found that when he had crystals of soap particles less than one micron in length, the grease was of smooth texture, and when the soap fiber length was from 1 to 10 microns the grease was of short fiber, almost a dehydrated sodium soap grease. These fibers are about 0.4 of a micron in diameter and the short fiber greases are used in ball bearings and different types of equipment where you have close fitting parts. When the soap fiber length is from 10 to 100 microns, the grease is of medium fiber. This type of grease is used in wheel bearings.

Leader: What is the magnification?

Pupil: 1000 microns diameter. Anything of 1000 microns is called long fiber. I want to write some of the chemical reactions that take place in soap formation for grease manufacture. Soap may be made by the hydrolysis of a glyceride or by direct neutralization of fatty acid. Klemgard gives a formula of $C_3H_5(OC_{17}H_{35}CO)$. In order to form a complete grease from this, you would have to use three molecules of sodium hydroxide:

$$C_3H_5(OC_{17}H_{35}CO)_3 + 3\ NaOH \longrightarrow 3\ RCOONa + C_3H_5(OH)_3$$

One molecule of NaOH reacts and

OBSOLESCENCE *spins its web with astonishing rapidity. Spurred by the fast-shifting needs of war, planes and tanks of a year ago are already outmoded. Explosives are more powerful; aerial bombs bigger and more effective. Aviation fuels are being produced faster, in greater yield, and in higher quality. Chemicals are being manufactured by better processes and more efficient equipment. Change is everywhere. And the end is not in sight.*

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cuts out glycerin, leaving the sodium soap and when the reaction is completed there will be three molecules of soap plus one of glycerin. The Germans in the last war took over some grease plants and operated them for the manufacture of glycerin. This is the reaction of the fatty acids:

$C_{18}H_{35}COOH + Na(OH) \longrightarrow$
$R\,COO\,Na + H_2O$

The fatty acids themselves are used for grease-making and in that way they react with one molecule of sodium hydroxide. It has been the experience of grease makers that you can't use as high temperatures in drying out grease made from fatty acids, and if you know anything about boiling point characteristics of glycerin and water mixtures, you know how high that is. The glycerin will actually hold the water at a higher temperature. I won't go into grease-making. You can see that the production of glycerin is an extra step from the neutralization of the acid, but can be carried to completion and is used in a great many plants; in fact, most of them use fatty acids. The end product is the same with either fatty acid or glyceride. We were talking about the tristearin. You may not always have that tristearin. You may have $C_{18}H_{35}$ here and we will say you have $C_{18}H_{33}$ here, which would be oleic, and down here you have $C_{18}H_{31}$ which I believe is linoleic. You have that complication all in one molecule and that is not theory. You actually have it.

$$2\,RCOOH + Ca(OH)_2 \longrightarrow \begin{matrix} RCOO \\ RCOO \end{matrix}\!\!>\!\!Ca + 2H_2O$$

One method that is used for making calcium soaps with production of glycerin is:

$C_3H_5(OC_{17}H_{35}CO)_3 + 3\,NaOH \longrightarrow$
$C_3H_5(OH)_3 + 3\,C_{17}H_{35}COONa$

Calcium chloride:

$CaCl_2 + 2\,C_{17}H_{35}COONa \longrightarrow$
$NaCl + (C_{17}H_{35}COO)_2\,Ca$

You can prepare calcium soaps in this manner, which is used if you want to recover glycerin.

Leader: Was that very extensively done during the first World War?

Pupil: I don't know for sure. I don't think there is any reaction derived from mixed sodium calcium. I might state that there are two different ways of doing that. It is possible to saponify by the mixed alkalies of calcium and sodium and both processes are used. It is just owing to what type of grease you are trying to get or along what lines of research the work is being done. With aluminum, some of the grease manufacturers are buying their aluminum soaps, which has some advantage. The manufacture of aluminum soap is a chemical industry and does not belong in grease making. Aluminum soaps may be stearates, oleates, or mixtures of all. I think the only one on the list of any commercial significance is aluminum stearate. The fat has a titer of about 54, whereas pure stearic acid has around 63; so the commercial stearic acid is not pure stearic acid. Aluminum soaps are usually made by the double decomposition reaction as follows:

$RCOOH + NaOH \longrightarrow$
$RCOONa + H_2O$
$2\,RCOONa + CaCl_2 \longrightarrow$
$(RCOO)_2Ca + 2\,NaCl$

I might state that one of the difficulties with this process is that you don't completely dry the soap before oil is added, and there have been some instances of sodium sulphate crystals being very bad for bearing lubrication. Aluminum soap forms a jell-type grease.

Leader: Now, we will have the manufacturing part of grease.

Pupil: I am going to stick to the greases already listed because others are unimportant anyway. In choosing materials for grease-making, the oil is the most important—mineral oil, as the soap has no lubricating value at all, and for any job an oil should be chosen to use in grease that would be chosen to do the job if oil were being used. In choosing the saponifiable oils, the most common are the glycerides, whole fats, good grade of tallow or lard oil and one of the most popular, horse fat; however, there is some shortage of horse fat, and then fatty acids, either animal or vegetable. They do not seem to have the favor that glycerides do, however, because they are hard to work with, especially in calcium soap greases. The fats of glycerine have a somewhat oily appearance and fatty acids are more brittle and lumpy and somewhat higher in melting point and harder to saponify. In starting with the calcium soap manufacture, it can be made in either an open steam-heated or fire-heated kettle, but preferably is cooked under pressure, and the open steam kettle is a longer operation and it is hard to control the water content, so nearly always the pressure kettle is used. In this installation a 300-gal. cast-iron kettle is commonly used. The fat to be used is charged first through the kettle, lime is mixed, then steam, oil, and water. A typical charge would be 1000 lb. of fat and the theoretical amount of lime to saponify the charge about 195 saponification number. This would give approximately 14½ lb. of lime to saponify the fat and in charging that 1000 lb. of fatty acid, approximately 800 lb. of mineral oil and 145 to 145½ lb. of lime would be used. The theoretical amount of lime to saponify the fat is not enough so it is customary to use a small amount of sodium hydroxide in the calcium soaps. Some grease-makers have different ideas, but 1 lb. per 100 lb. of fat would be a logical amount. In charging 800 lb. of mineral oil in the lime, so there would be no lumps left, it is added to the melted fat and approximately 10 to 15 gal. of water. The solution is from 25°—40° Bé gravity. In the mineral oil, it is best to use low viscosity if you are using a medium grade of mineral oil, about an SAE 30, which is common to most pressure gun greases. The low viscosity oils should be used in the soap grease and then oil added. The saponification is carried on all right by the soap. It is hard to handle with heavy oil in it. After the lime slurry is added to the kettle it is closed and agitated for a short time and the steam applied to the jacket at about 100-lb. pressure. The temperature is taken to 100° around one hour. Gives you 30-40 lb., and the ordinary practice is to blow soap from the pressure kettle into the mixing kettle and then water is flashed off. There are different ways grease-makers use in determining the amount of water they will end up with. Some allow all water to flash off and then add the amount they want in their finished grease; however, the amount they retain will be determined by experience. There is still going to be some evaporation. It doesn't make any difference which way the finished grease winds up, with 0.5 to 1 percent water. After the soap is blown into the mixing kettle, the balance of the oil is added slowly in sufficient amounts to give the required consistency. In making fatty acid grease, the water content should be held at about 0.5 to 1 percent or even lower than that, perhaps 0.3 to 0.5 percent to give a diluent semi-transparent grease. In using glycerides, you use a higher water content to get a larger yield. The pressure kettle used can supply soap to a number of mixing kettles, from two to four, and the finished grease is drawn through a screen into containers at approximately 180°F. temperature. Immediately after the soap is blown into the open type kettle, the grease maker checks it for complete saponification, and excess alkali. He could send samples to the laboratory, etc., but it takes time, so he just learns from experience when he has complete saponification. In sodium soap, the usual method is to handle it in a direct-fired kettle. It can be made in a steam kettle, but it is very slow and very difficult to reach the degree of dehydration required with sodium soap; however, some sodium soaps are made with high water content when the soap is going to be used in gear lubrication and bearings and a high yield is the most important factor and tough fiber, but the best sodium soap greases are made with as low water content as possible. The high water content greases have a very low melting point. Glycerides are

used more widely in fatty acids. The caustic soda is figured on the same basis as lime, 15-15½ lb. of fat. Before the caustic soda goes in, a small amount of mineral oil must be added, about 500 to 600 lb. to 1000 lb. of fat. It is run for 30 minutes and allowed to soak up and the temperature taken slowly to 250°-300°, which requires about two hours. From there it is pretty well up to the grease maker's skill or practice as to how high the temperature shall go. Generally, the fire is cut at that temperature and the temperature is allowed to decline to 300°-350°. The step is a very important one and requires close attention. When the soap is dehydrated, the grease maker begins adding mineral oil. He finishes his batch at about 200°F. Some manufacturers use a mill if they want a smooth fiber grease. They can produce a grease that is of a short, buttery texture almost similar to cup grease. This gives a consistency that will not soften by further working. Sodium soap has much harder consistency as a general rule. Saponifying the two together is a very delicate operation. The water content is very hard to handle. The aluminum soap is added to the kettle with approximately half the mineral oil mixed cold to make a paste and the rest of mineral oil added and heat applied to the kettle to bring the temperature to 250° to 300°F. to remove moisture, when it is poured into shipping containers or shallow pans and allowed to cool. The consistency of the finished grease is determined largely by the cooling rate. The faster it cools, the harder grease it contains. In the aluminum grease, it is necessary that heavy oil be used to get a good product. As the viscosity of the oil goes up, the more cohesive the grease becomes until an extremely high viscosity is attained and you get, instead of a buttery grease, almost a stringy, sticky fiber. Ordinarily I think the most common lead soap is lead oleate; in the saponification of lead soaps, generally oleate is added to lead oxide and is added to the kettle with approximately half the mineral oil and forms a paste; then the fat is added with the balance of the mineral oil and worked into the paste that is smooth before any heat is applied. It is then heated for two or three hours. It will not show much change until a temperature of 275°F. is reached and then there is a sudden foaming and the reaction at that stage is very rapid because the grease will change in appearance very rapidly and saponification is practically complete in just a few minutes.

Leader: Which mineral oil is that?

Pupil: Klemgard did not say. We made some lead soaps using 120 viscosity oil. I don't know of any particular reason for using higher viscosity oil, because there is only enough mineral oil used to make soap easy to handle. I assume low viscosity oil would be used in most all cases because it is easy to handle.

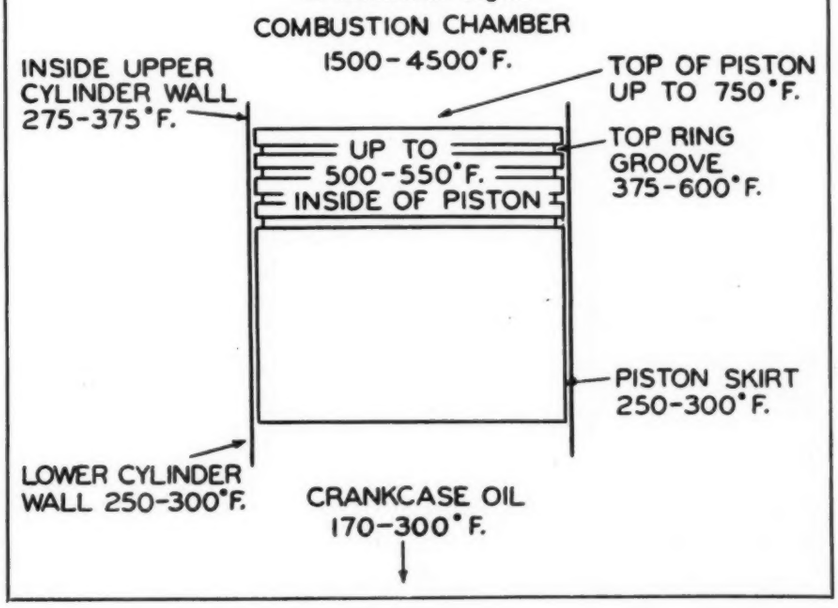
Pupil: Is there any such thing as a mixed base grease like aluminum and calcium or sodium and calcium or does aluminum always have to be used by itself?

Pupil: I believe there would be no object in mixing them.

Pupil: You can mix aluminum and sodium.

Pupil: Yes, you can mix them and this is done by some companies. It is done to smooth the texture.

Fig. 26. Typical temperatures encountered in cylinder lubrication of automobile engine



Pupil: It cuts the yield, but I have done some experimental work and a very small amount of aluminum soap will make a sodium soap grease of buttery texture, but still retain a high melting point characteristic of sodium soap grease.

Pupil: Would you just briefly tag each one of those greases and give the service they are most adaptable to?

Pupil: Calcium soap—cup grease for pressure gun. Pressure gun grease has high viscosity; is used for shackle lubrication and for farm machinery. Sodium soap is used for gears; calcium soap and sodium soap are made in a wide range of consistencies and are used in a wide field of service; they are used in spring shackles, as a general automobile lubricant, and in farm machinery; however, calcium soap is never used as a gear lube.

Leader: Would you think fiber is largely responsible?

Pupil: Yes. Aluminum and calcium come under the same classification as the calcium and sodium mixtures as far as application is concerned except there is no particular reason to use them as gear greases. Aluminum soap is used in making chassis lubricant, or general pressure gun lubricant. I don't believe aluminum soaps would be used in wheel bearing greases; they soften too easily.

Pupil: Aluminum soap base grease is a particularly good shackle lubricant because it does not leave deposits in the shackles and is very stable to oxidation; the soap does not separate between oil and pressure.

Leader: Does it have a high resistance to water?

Pupil: Yes, a very high resistance to water. That is an objection to sodium soap—it has a poor resistance to water.

Leader: Concerning lead soap, it is very essential to have it present in the case of using sulphur because of its resistance to corrosion.

Class Meeting No. 12

Leader: A few years ago, automobile engines all had rather large clearances between the bearings and moving parts and when they did the industry quite often met the situation by using a high viscosity oil. Now year by year we see the efficiency of these engines going up and that efficiency means more power per cubic inch of displacement and higher temperatures mean higher pressures, etc.; so we are having more and more attention paid to this subject which some choose to call "oiliness." We defined oiliness at another class meeting.

We decided that when we talk about oiliness we are discussing that characteristic which represents less friction in one oil than another when both are of the same viscosity at the operating temperature and so we will agree

(Continued on Page 116)

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(Continued from Page 113)

for the moment that oiliness is an important subject. Perhaps we should get practical and put a diagram on the board to determine just about what conditions the automobile engine has to face. (Fig. 26.)

We shall imagine these are the walls on the cylinder and we have a tightly fitting piston. Probably we will have as many as four ring grooves, and not any particular make of car, in mind. In order to get at this problem we are facing I would like to enumerate some pressures and temperatures. That is the combustion chamber and connecting rod, and down in here we will have our crankcase oil. One that will typify most of the cars of recent make which have ventilated crankcases and also operate at rather high temperatures, 170°F. to 280°F. When this temperature is given, I am referring to heavy-duty operation, "stepping on it" in other words. The oil will be splashing up and touching the underside of the piston. On top we will have a combustion chamber that might reach temperatures of 4000°F. to 4500°F. That is somewhat higher than it was 15 years ago. The underside of that piston will not be that hot. There will be water jackets down the side of the cylinders and water jackets on top and the underside will have the benefit of that cooling and also will receive the effect of the cooling when we bring in the intake charge; probably 500°F. to 550°F. The inside of the upper cylinder wall will likely be about 275°F. to 375°F. This ring groove, the top one, will probably be somewhere in that range, 375°F. to 600°F., and the lower part of cylinder and skirt will be about 250°F. to 300° F. So much for temperatures. The pressure on the bearing is expressed in two different ways and sometimes there is a question regarding whether we are referring to projected area or actual surface of the entire bearing circumference, but from a projected area viewpoint the connecting rod bearings are undergoing pressures of 2200 to 3000 lb. per sq. in. What do you think happens when the oil is pushed up into the combustion zone?

Pupil: It is carried out through the exhaust.

Leader: A portion of it is carried out through the exhaust and some is wiped back down the cylinder; probability is we will have some oil going up and remnants, including the residue, coming down. When you get your power impulse, this oil would roll up and seal this part of the piston, but it is inevitable that some gases are going to blow down past those rings and that is an opportunity for contamination of the oil.

Pupil: Which would be the best condition; to have some of it escaping into the exhaust?

Leader: From the viewpoint of lubrication?

Pupil: Everything considered.

Leader: You would not want to lose lubrication—do you think you should scrape it all back down the cylinder walls by extreme oil ring action during the down stroke of the piston?

Pupil: No.

Leader: I don't believe you should, either. Too clean a removal of oil by oil rings would be detrimental to lubrication.

Pupil: Isn't that one of the explanations for the Ford Motor Company advocating larger piston clearance, saying that if a car does not use some oil, it isn't getting proper lubrication?

Leader: I believe that is the case. They lean toward higher viscosity and higher boiling point oils. That is, of course, one of the schools of thought. You never have agreement and everything you do is a compromise. So some believe that you should allow the oil to get by and there are others who do not subscribe to that theory.

Pupil: Some of it is going to get by, though, and the harder the car is pushed the more that will be true.

Pupil: It is an established fact that the modern car in good condition can be driven at 60 mi. per hr. for 500 miles with less than a quart loss and have good lubrication and that is very little loss.

Leader: Let us look at some typical figures:

(Writes)

Typical used oil	Percent
Dilution	5
Total insolubles	1
Ash	0.33
Ash analysis	
Lead oxide	80
Silica	5
Iron oxide	15

At one time those dilution figures were much higher, but with crankcase ventilation the situation has been improved. We have a crankcase temperature of 170°F. to 280°F. and there seems to be general agreement that at about 235°F. to 250°F. oxidation begins at a rapid rate. What about the possibility of some catalytic action involved?

Pupil: I imagine there would be. Virtually all metals present have catalytic action and the temperatures at the top of the piston are far greater than those required for decomposition.

Pupil: Are those insolubles sludges?

Leader: No; I did not mention water. I left that out whereas it is one of the most important contaminants. I will list them:

Water
Soot
Lead sulphide—emulsifiers
Fuel residue—dilution
Dust—mostly past rings
Metals—wear and dissolved
Oil decomposition—
  Soluble acids
  Insoluble asphaltic

Water will come from leaks in the cooling system, but more likely from condensation and here is a point to think about: if you drive at temperatures of 130°F. to 135°F. with any cooling system you are likely to have water condense in the oil, particularly on short trips and that may lead to trouble with emulsions. The figure isn't common when considering the millions of cars, but yet there are many of them that have trouble and one remedy is to change to higher range thermostats and use a winter-front. If you have soot present, and you do, I presume we will agree that it is blown by the rings from the combustion chamber. Lead salts have to come down from the gasoline and they are rather bad emulsifiers, and then fuel residue will account for dilution. I don't believe the latter is harmful, though. We might consider where metals come from. First, probably wear, but some of it no doubt comes from chemical action of acids formed in the oil. Insoluble asphaltic matter may be something like 1 percent. We have all those elements churning up and down in an engine; think what abrasive action is taking place. If we may assume that every possible step is taken including use of a filter, perhaps then we can approach the subject of oiliness with regard for its opportunities. How about the need for oiliness? Do you think we need an oiliness characteristic to have optimum lubrication?

Pupil: Nothing beyond the mineral.

Leader: I mean any addition agents.

Pupil: Some of the mineral oils could be classified as addition agents.

Leader: Don't you think that conventionally refined oils have that oiliness tendency? And with the solvent you remove some of the natural beneficial constituents? How about lubrication of these heavy-duty vehicles?

Pupil: That is entirely different.

Leader: Fifteen years ago trucks did not pass passenger cars on the highways very often, and now it is quite common to have a truck or bus sail by you and those heavy-duty requirements certainly change the complexion of this problem. So now the experiences of two or three years ago don't apply. Do some of these agents reduce friction? Can you give any specific examples?

Pupil: Fatty acids are supposed to.

Leader: Have you seen or made any tests yourselves?

Pupil: I have seen tests some of the companies have put out. I imagine they are reliable. (To be continued)

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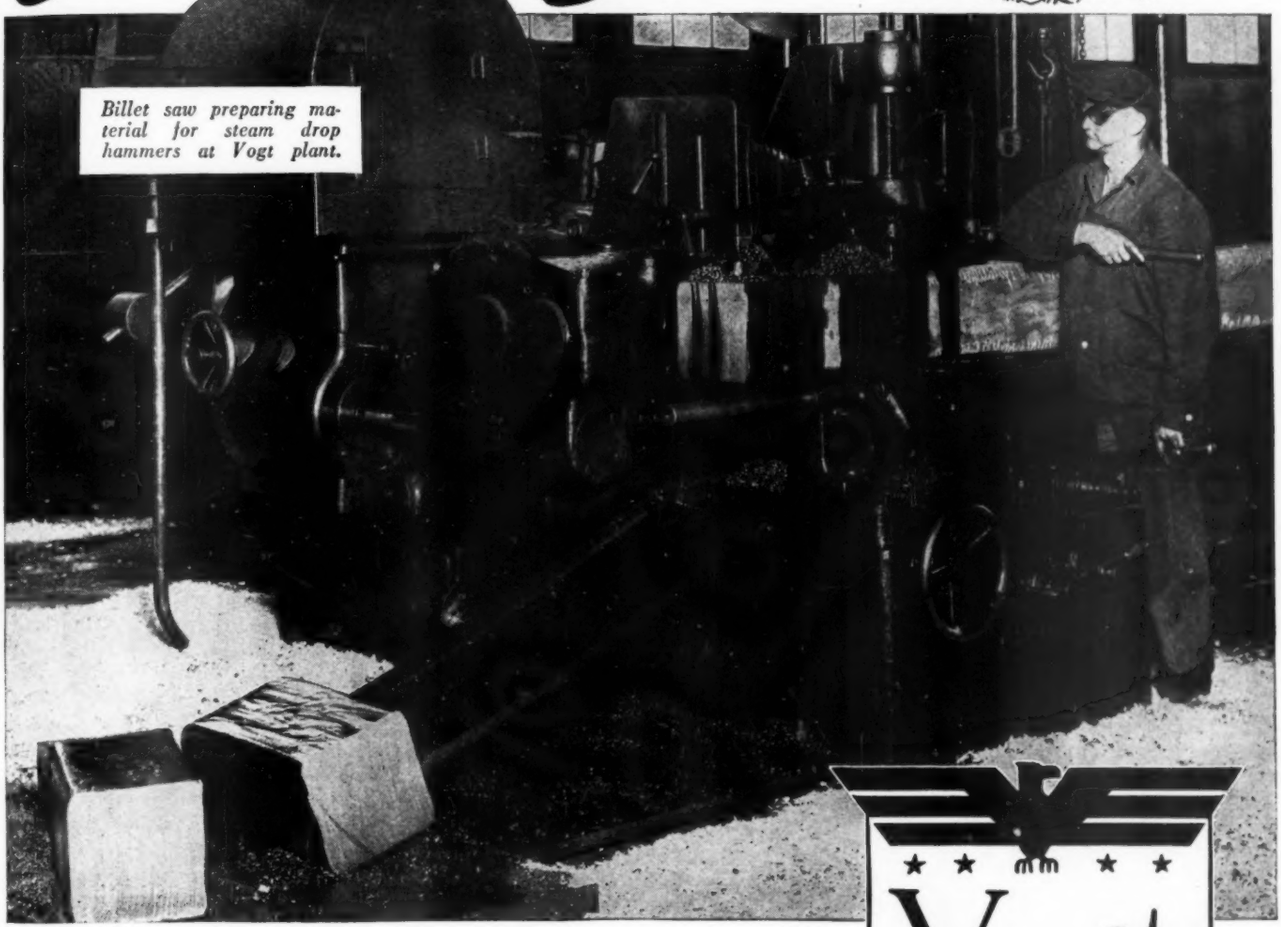

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Physical Variables Influencing Well Spacing

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☆ **Thorough knowledge of subsurface conditions essential to intelligent planning**

by Lester C. Uren

Professor of Petroleum Engineering, University of California

WHEN a sufficient number of exploratory wells have been drilled in a newly discovered field to define the productive area and to yield dependable information concerning the character of the reservoir rock, its contained fluids, and the expulsive forces operative, each oil producer operating in the productive area is confronted with the problem of planning a development program for his property that will yield a maximum profit. How many wells should be drilled? How far apart should they be spaced? What pattern should be adopted for arrangement of the wells? When should each be drilled? These and other related questions are of vital importance in determining whether or not the operations may be profitable and to what degree.

Vast sums have been wasted in conduct of improperly planned development programs: probably more than the value of all the oil and gas thus far produced. Here, perhaps more than in any other phase of oil-field exploitation, is the opportunity presented for the petroleum engineer to demonstrate his worth. Petroleum engineering principles afford the only dependable guides in the scientific planning of an economic development program. The problems presented demand a broad understanding of all phases of the oil-producing industry. The engineer must be thoroughly conversant with the subsurface conditions, with field development and producing practices, and with costs and market conditions, before he can intelligently analyze the problem presented. He must envisage the entire productive life of the field and be able to forecast the trend of the industry during the economic life of his property, if he is to plan the most efficient development program possible. It is a service that demands engineering talent of the highest degree.

In this and other articles that will appear in successive issues of *The Petroleum Engineer*, the writer will attempt to review the more important problems presented in planning a development program for an oil-field or oil-producing property. In this review, an effort will be made to reflect and give perspective to ideas presented in many authoritative, technical papers of recent years, dealing with oil-field development problems. The material presented is intended primarily to be a review of the recent literature on this subject, designed to bring together, and when possible reconcile, conflicting views, and generally "take stock" of progress recently made in this phase of petroleum engineering.

LESTER C. UREN

Oil-Well Spacing Problem

For many years, petroleum engineers have been aware that the economic spacing of wells is one of the most important unsolved problems of the petroleum-producing industry. The writer first attempted[37] to outline the problem in 1926, and in later efforts sought further to define it [38], [39], [40] and to indicate possible methods of reaching a practical solution[42]. More recently, many others, recognizing the importance of this subject, have written authoritative papers dealing with various aspects of it, as will be apparent on inspection of the selected bibliography that appears herewith. In some oil-industry centers, special study groups of interested engineers[16], geologists, and oil-company executives have been organized to review the literature and create a forum for intimate discussion. Since 1932, the American Petroleum Institute has maintained a Well-Spacing Committee[45], comprising a group of competent technologists, charged with the responsibility of collecting data and maintaining continuity of interest looking toward ultimate solution of the well-spacing problem.

Although great progress has been made during recent years in clarifying the many factors that are involved in determining the economic spacing of wells, it must be admitted that as yet it has not been possible to formulate all the variables to the point of developing an all-inclusive formula that would permit computing mathematically the proper interval between wells for a given set of conditions. Some of the factors are intangible or cannot be evaluated precisely, and judgment enters to an important degree in the practical solution of the problem. Nevertheless, much may be accomplished in reaching a reasonable approximate solution by a careful analysis of the controlling factors. Both physical and economic factors are involved, and the engineer must be familiar with many phases of petroleum production technology and economics before he is capable of intelligently analyzing the well-spacing problem. This article seeks only to review the more important considerations presented, insofar as they can be ap-

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Well spacing is not a matter upon which it is safe to generalize; the physical conditions presented in each field must be considered carefully before intelligent decisions may be reached. Different areas in the same field may require different spacings for the best results. Well spacing must also be considered in its relation to other phases of the development program and plans for future exploitation of the property.

In approaching this problem, one must remember that the objective of the oil producer is not necessarily to produce the greatest volume of oil that his property is capable of yielding. His primary object is to realize maximum profit from it, and usually a greater profit is achieved with something less than the maximum possible ultimate recovery. The interest of the producer may therefore be at variance with that of the royalty owner, the government, and the consuming public, whose interests are best served by adoption of spacing programs that will result in production of a maximum quantity of oil.

A development program suitable for a property exploited under competitive conditions, will naturally differ from that appropriate for the same property when it is situated in a unitized field, or in a field where cooperative principles are to govern the development program.

One must plan the development program in accordance with his concept of the character of drainage operative in the field under consideration. A development program appropriate for a "water drive" field would differ markedly from that suitable for a field where gas energy is supplying the expulsive force. The spacing program in a gas-cap area or in a "distillate field" is quite unlike that appropriate in areas where the reservoir rock is oil-saturated.

Influencing Reservoir Conditions

In determining upon a suitable spacing for wells in a given field, it will be important to consider the lithologic characteristics of the reservoir rock and the nature of the expulsive forces operative. One's concept of drainage must be predicated upon these fundamentals. The reservoir rock, whether a sand, sandstone, or limestone, must possess porosity for fluid storage capacity, and it is essential if drainage to the wells is to be effective, that the pore spaces be at least partially intercommunicative. The resistance offered to fluid flow through the pore spaces, will depend upon the size and shape of the pore openings and the character of surfaces they present to the fluids passing through them; also, upon the viscosity of the fluid and interfacial force existing between it and the mineral surfaces. In addition to liquid and gaseous varieties of petroleum, water may also be present. The lithologic characteristics of the reservoir rock and physical properties of the reservoir fluids may vary widely, not only in different fields, but in different parts of the same field, and the interval between wells should logically be varied to accord with changes in these characteristics.

Character of the expulsive forces operative and their influence on well spacing. The expulsive force operative in overcoming resistance to movement of fluids through the reservoir rock and propelling them toward the well outlets may be created by edge-water pressure, expanding gas, or gravitational force. The writer classifies all fields in two categories insofar as the influence of expulsive forces is concerned: (1) fields in which edge water encroaches as rapidly as fluids are withdrawn through the wells, so that the formation pressure is substantially maintained, and (2) fields in which edge water does not encroach, or does so less rapidly than reservoir fluids are withdrawn, so that formation pressure declines as the reservoir is depleted. The first type of field is often called a "water-drive field," or one under "hydraulic control." In the second type of field, expanding gas supplies the expulsive force, and for this reason is often referred to as a "gas-drive field," or one under "volumetric control." The well-spacing pattern adopted will depend upon which of these two types of controls is considered to be operative. Gravitational force is always operative, and may at times exert an important influence on the efficiency of drainage, especially in the latter phases of depletion of a reservoir where expanding gas is supplying the primary expulsive force.

When the reservoir rock is highly permeable and continuity of pore spaces permits rapid equalization of pressures throughout the reservoir, edge water under static pressure from the level of the "water table," may enter the formation as rapidly as oil and gas are withdrawn, thus tending to maintain pressure throughout the reservoir; though, of course, formation pressures are necessarily somewhat reduced in the vicinity of the producing wells. Under such conditions, wells may be widely spaced without adversely influencing the ultimate recovery. Indeed, as has often been suggested, one well situated at the crest of the structure, may in time produce all the oil and gas from such a reservoir. Additional wells need to be drilled only when competitive conditions exist between different tracts producing from the same reservoir, or when it is desired to produce at a more rapid rate than is possible with a single well. Many fields are of this type: for example, the Yates field and East Texas field in Texas, and the Hobbs field in New Mexico.

When the edge water is stationary or unable to enter the reservoir as rapidly as fluids are produced, quite a different situation exists. Expanding natural gas under pressure, associated with the oil, supplies the active expulsive force; and as the gas and oil are produced, the formation pressure diminishes. Drainage leaves a part of the pore space of the reservoir occupied with free gas, and gravitational force brings about segregation of the gas and residual oil. If the edge water is stationary, the volume of the reservoir remains constant. If edge water is slowly encroaching, the volume of the reservoir will diminish and thus tend to restore pressure in some degree. Many fields are of this type; probably the majority of American fields fall in this classification.

When the edge water remains stationary, it is probable that there is some optimum number of wells, or some certain spacing interval, that will result in production of the maximum quantity of oil. If the edge water is slowly encroaching and we are content to adjust the rate of production to the rate at which edge water may enter the reservoir, "water-drive" conditions may be maintained and wide spacing of wells may suffice. Or, we may take production at faster rates but shut in the wells occasionally, so that the more slowly encroaching edge water may have time to restore a higher formation pressure.

Herold,[15] in discussing the case where edge water is stationary and expanding gas is the only source of energy available for expelling oil—a type of drainage that he calls "Paleozoic production"—asserts that where this method of production is operative, each well has a definite drainage radius and performs independently through its entire life of every other well drilled outside of its drainage "cone." He concludes that in this type of production there is no bypassing of oil by gas, no escape of gas from the drainage area of one well to that of another outside of its oil-drainage radius. The time of drilling is of no consequence under these conditions; early wells in a field have no advantage over later drilled wells. Under such conditions, efficient recovery of the available oil would require that wells be accurately spaced at a distance of twice the fixed drainage radius determined by Nature, and wells drilled within drainage radius of each other would share the drainable oil locked by natural resisting forces within their drainage area. This concept is something akin to Herold's "capillary control" idea developed in

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his earlier work, which has found many supporters; but others have professed doubt concerning the practical efficacy of "Jamin action," upon which this concept rests[14].

Reservoir rock resistance to flow and its influence on well spacing. Of the original oil present in the reservoir, only a portion is recoverable. The remainder must remain in the reservoir rock, held by the force of adhesion on the mineral surfaces and by capillary force in the smaller recesses and in zones of capillary retention in the lower portions of productive strata. The percental recovery will depend upon the permeability of the reservoir rock, the expulsive forces available, and the efficiency with which these expulsive forces are utilized. Efficient utilization of the expulsive force is partly dependent upon the method of exploitation and well control adopted by the producer. The number and spacing of the wells drilled is one of the variables influencing production efficiency that is within the control of the producer.

Generally speaking, it would appear to be inefficient to force oil to flow through highly resistant communicating pore spaces of the reservoir rock to a distant well outlet. The shorter the distance that the oil has to move through the reservoir rock, the less will be the consumption of reservoir energy and the greater will be the efficiency of energy utilization. The consumption of reservoir energy is not directly proportional to the distance traversed, however, for conditions of radial flow require that the greater part of the energy be consumed within a few feet of the wall of the well. Pressure loss and energy consumption are proportional to the rate of flow, and in radial flow, the rate of travel through the reservoir rock is so low at points remote from the wall of the well that pressure loss and energy consumption are negligible in comparison with losses near the wall of the well. Thus, more energy is consumed in moving oil through the 3 ft. of reservoir rock immediately adjacent to the wall of the well than through the next 300 ft.[42] Only 10 percent more pressure is necessary to force a given quantity of oil through a radial flow system 660 ft. in radius than through one 330 ft. in radius with otherwise comparable conditions.[24] From the energy consumption standpoint, one might conclude from these statements that the interval between wells is of little consequence in its influence upon oil recovery efficiency.

When gas energy is providing the expulsive force, the interval between wells may have an influence on the effectiveness of oil recovery, as a result of inefficient application of gas energy in moving oil through the reservoir rock; and this may operate disadvantageously in cases where the wells are widely spaced. As formation pressure is diminished by production of oil, gas is released from solution in the residual oil in the reservoir rock. At points remote from the wells, where fluids are moving slowly, gravitational force tends to segregate the gas from the oil, concentrating it in the lower portion of the reservoir rock while the gas rises to the upper portion. Thus, gas may escape to the well outlets through oil-drained spaces in the upper portion of the reservoir, from areas remote from the well outlets, without doing useful work in moving oil. Gas drainage of this sort may occasion a serious wastage of reservoir energy that could perhaps be largely avoided by close spacing of wells and rapid production of the gas and oil.

Muskat,[25] by a process of mathematical analysis of data derived from laboratory studies, reaches the conclusion that in a gas-drive field, from a strictly physical viewpoint, the percental recovery available is independent of the well spacing and is uniform through the reservoir at all distances from the wells. This conclusion, however, is based on the assumption that pressure declines uniformly throughout the reservoir to the same degree, so that no residual pressure gradient exists, and that infinite time is available for the depletion process. Muskat readily admits that these limitations are impossible of attainment in field operations, and that time restrictions and lower economic limits of profitable operation of wells will modify this concept of ultimate drainage recovery.

Most authorities adhere to the orthodox view—seemingly confirmed by field results — that percentage of recovery varies in some ratio with distance from the walls of the wells; that in the vicinity of the wells, high percentage of recovery is obtained, whereas at points remote from the wells, the reservoir rock is left more highly saturated. There would appear to be ample reason for this expectation, for if movement of the oil through the reservoir rock results largely from the "scrubbing" effect of gas bubbles moving through the drainage channels, this effect would be accentuated in the vicinity of the wells where more gas passes and where flow velocities are higher. It is to be noted in this connection that gas reaching the well has its origin in oil from all parts of the area within drainage influence, and that only a small part of the gas has originated in the outer portions of the drainage area. Oil in the reservoir near the well is therefore subjected to the scrubbing effect of all gas from the more remote points, whereas in distant portions of the reservoir, the oil yields its dissolved gas on reduction of pressure but derives only slight impetus tending to move it toward the distant well from other energy sources.

Is there a "drainage radius?" In technical papers dealing with drainage of oil reservoir rocks, one often finds the term "drainage radius," used with reference to the distance over which fluids are capable of moving through the pore spaces of the reservoir rock to a well outlet. Some authorities have reasoned that fluids in the reservoir rock about a well are restricted to a definite distance over which they may move toward the well under a given set of reservoir conditions, and that wells should be spaced no more than twice this distance apart; otherwise undrained oil will be left in the reservoir.[15] This appears to be a misconception, for recent studies have indicated that theoretically—in a physical sense—there should be no limitation placed upon the distance over which fluids may move. This seems clear, at least, in the case of a well producing in a field under "water drive." Here the formation pressure is sustained, the pore spaces of the reservoir rock are always saturated with oil or water, and there is always a pressure differential capable of causing flow into the well. Oil will eventually reach the well in such a reservoir, no matter how remote.

In gas-drive fields also, it seems probable that fluids may move toward the producing wells over distances greatly in excess of intervals commonly suggested as probable drainage radii. At least, during the early period of drainage, when the pore spaces are filled with liquid, there can be no break in the continuity of the fluid mass at points remote from the well. Flow from the formation into the well necessarily requires some movement of fluid through all surrounding communicating strata, though it must be admitted that at remote points, the motion may be so slight as to be scarcely perceptible. The fact that a particle of oil was at one time in motion toward a well, however, gives no assurance that it will ever reach the well and be produced. As reservoir pressure diminishes and oil-drained voids are left in the reservoir rock by depletion, gas escapes from solution in the oil and fills these spaces. As explained in an earlier paragraph, these oil-drained channels form in the upper part of the reservoir rock while oil is concentrated by gravity in the lower portions of the reservoir to which it has access. The more permeable portions of the reservoir rock are first drained, leaving bodies of surrounding, less permeable rock comparatively well saturated with oil, held by the forces of capillarity and adhesion. Residual oil is eventually left in the less permeable portions of the reservoir rock, drained of its gas energy and

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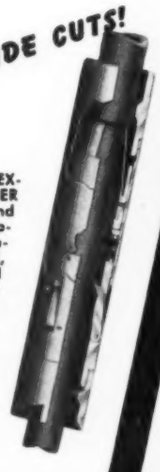

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capable of further movement only by comparatively slow gravitational seepage. Thus, oil that may have been initially in motion toward a well, under the influence of a high pressure differential, may be left immobile in the reservoir rock, still far from the wall of the well, or perhaps slowly gravitating toward some lower part of the reservoir.

In one sense, a well producing under gas drive may be said to have a drainage radius, if this be defined as the maximum distance over which oil may move toward the well and eventually be produced by that well; but this is a lesser distance than the radius of influence of the well. In this connection, it is important to note that gas may flow toward a well and eventually be produced, over a much greater distance than the associated oil. Thus, a well may be considered to have a gas-drainage radius capable of draining gas and reducing formation pressure over large areas—perhaps over the entire "structure." Areas too remote possibly to yield their oil to a well, may yield their gas; and later drilling in these more remote areas will find the reservoir rock well saturated with oil but drained of its gas energy and therefore producible only at very slow rates.

Time is necessarily a factor in any consideration of drainage radius. If we could go on operating a well forever, we might hope eventually to produce oil from these remote areas, except that oil necessarily held by adhesion and capillarity. There is a lower limit in the rate of profitable operation for every well, however, and unfortunately the minimum profitable rate of production is such as to leave much of the original oil content economically unrecoverable where wide spacing is practiced in a gas-drive field.

Influence of lithologic properties of the reservoir rock on well spacing. The permeability, porosity, texture, degree of cementation, and other lithologic properties of reservoir rocks vary widely, and should doubtless be given careful consideration in any study of well spacing. In a highly porous reservoir rock, per-acre yields will be larger than in rocks of low percentage porosity, and wells can be more closely spaced and still "pay out." Permeability is most important, for if the resistance to flow offered by the reservoir rock is high, the rate of recovery on a per-well basis will be slow, and to drain a property within a reasonable time wells must be closely spaced. Wells in "tight" formations may quickly reach a rate of production insufficient to pay operating costs, after the early "flush" production has been procured; yet the surrounding reservoir rock may still be well saturated with oil. Pressure gradients, though still high, are incapable of yielding production at commercial rates. In the Clarendon field of Warren County, Pennsylvania, "five-spot" wells, situated at mid-points between wells that had been producing more than 50 years, and only 250 ft. apart, developed shut-in pressures as high as 50 lb. per sq. in. The sandstone reservoir rock at these five-spot locations, when cored, was found to be highly saturated with residual oil. Under such conditions, wells must be closely spaced if a reasonable percentage of recovery is to be obtained within a period of time that would be financially attractive.

Some authorities object to wide spacing of wells on the theory that in many fields the reservoir rock is widely variable in texture, even lenticular, with highly permeable sand lenses interlaced with shaley sands of very low permeability; yet, all portions of the reservoir may be well saturated with petroleum. When wells are drilled, oil in the more permeable portions of the reservoir will be quickly drained, but the less permeable portions will yield their oil much less freely. When the field pressure has been reduced to low values, edge water may find its way to the wells through the more permeable, oil-drained portions of the reservoir rock, thus inundating the interstratified less permeable beds still highly saturated with oil. It is believed that under such circumstances, a larger percentage of the recoverable oil will be recovered if the wells are closely spaced than if they are widely spaced.

It seems reasonable that block-faulting, stringers of secondary minerals deposited in small fissures, shale "partings," cross-bedding and other irregullarities in the strata comprising the reservoir rock may prevent free flow of fluids throughout the reservoir; that certain areas in the field are, in effect, isolated from other areas, and that a widely-spaced pattern of wells may leave some of these areas undrained. Close spacing of wells in such circumstances would seemingly give greater assurance of a high percental recovery of the drainable oil. Geologists who understand and appreciate the irregularities developed by Nature's processes of sedimentation and secondary cementation place more stress on the importance of such conditions than do engineers without geological training, who often lack appreciation of the probable influence of these conditions on drainage.

Influence of geologic structure and structural position on well spacing. Geologic structure influences oil and gas accumulation and drainage in many ways and must certainly be taken into account in planning a field development program. Several different types of geologic structure are known to be productive of oil and gas accumulations and each presents its own peculiar problems of well location and spacing. Position on structure is also an important consideration; thus, a property situated on the crest of a structure may require a different plan of development from that of another situated on one flank of the structure, near the edge-water line.

An accumulation on domal or anticlinal structure, producing under "hydraulic control," if operated as a unit, may yield a high percentage of recovery if exploited by a few widely spaced wells situated along the crest of the structure. Wells in this position will produce throughout the economic life of the field and will not be flooded with edge water until nearly all the available oil has been produced. If the field is divided into competitive tracts, however, the owner of an "edge" property would find it to his advantage to drill closely spaced wells in order to avoid loss of oil beneath his property to up-dip wells. To prevent up-dip drainage, wells should be more closely spaced in the direction of the strike of the beds than in the direction of the dip.

In a field where oil is expelled from the reservoir rock by gas pressure and the formation pressure declines as exploitation proceeds, there is often a gas cap at the crest of the structure. If there is no primary gas cap at the structural crest, one is likely to form there as a result of depletion and gravitational segregation of residual gas and oil remaining in the reservoir. In a gas-cap area, wells should be widely spaced, if drilled at all. Production should be taken from down-dip wells, so situated that they will drain as little gas as possible from the crestal area. Wells should be spaced in accordance with some uniform pattern that will make approximately equal areas of reservoir rock tributary to each well. Because of the greater surficial area of reservoir rock on steep-dipping flanks, wells may logically be more closely spaced with reference to the horizontal surface plan in the direction of the dip of the beds rather than in the direction of strike.

When a reservoir is highly permeable and edge water is stationary or advancing very slowly, gravity may slowly drain the residual oil from the crestal areas, concentrating it toward down-dip areas. Wells situated on the lower structural flanks may thus continue to produce oil after crestal wells have ceased to produce anything but gas. When such conditions exist, wells may be more closely spaced in areas near the edge-water line than in the crestal area. If the field is exploited as a unit, a single row of closely spaced wells near and paralleling the edge-water line, may efficiently drain the entire structure of its oil.

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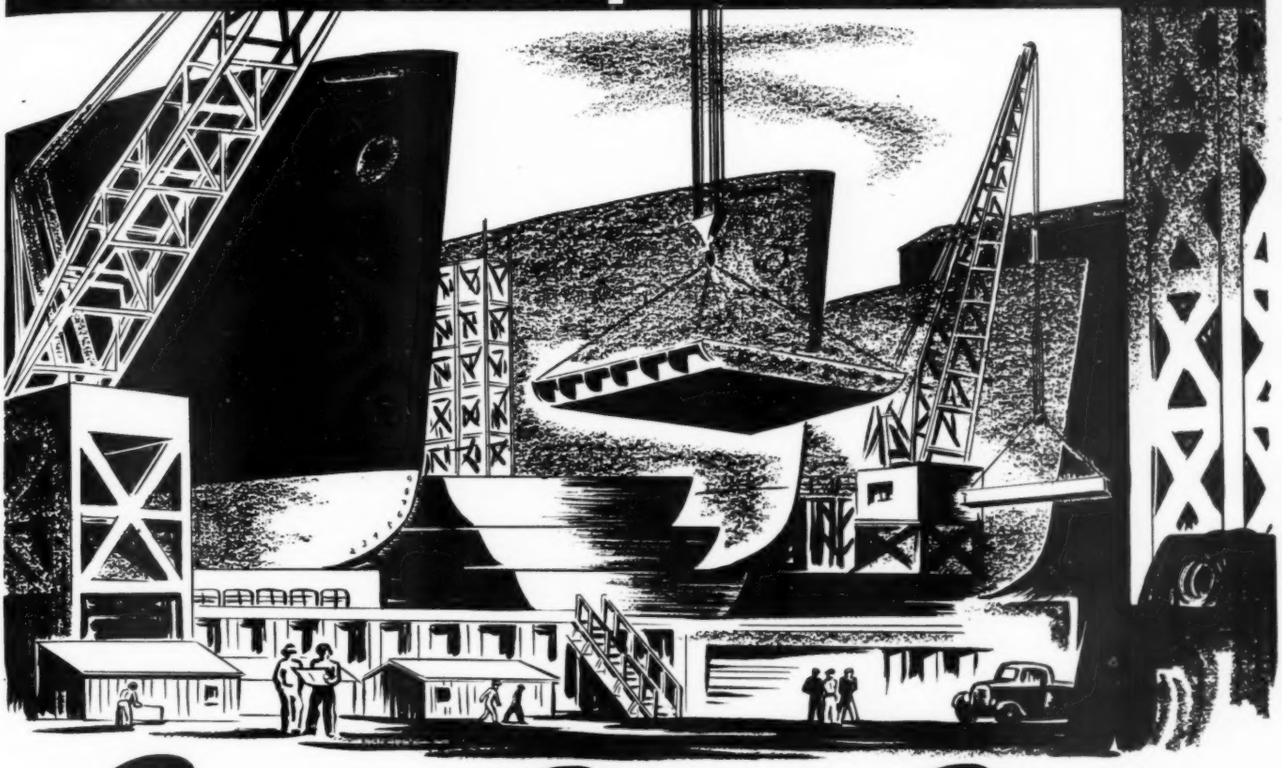

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Summary and Conclusions

In the present article, an effort has been made to review the more important factors of physical character that influence the spacing of wells in oil-field exploitation. It has been shown that the character of the expulsive force operative and the manner in which it controls drainage of oil from the reservoir rock, will be important considerations. Water-drive fields and gas-drive fields present fundamentally different conditions of drainage and the well-spacing program will be different in each case. Variations in the lithologic character of the reservoir rock—particularly its permeability—and in stratigraphic irregularities, will have an important influence in determining the distance over which a well may exert drainage influence. Only in gas-drive fields may wells be considered to have a natural drainage radius, and then only in the sense that time and economics interpose conditions that, from a practical point of view, determine an area of drainage influence. In this sense too, it is believed that higher percental recoveries are obtained from areas near the producing wells than from more remote areas within the reservoir. The effective radius of pressure influence and gas drainage probably exceeds that of oil drainage. Geologic structure, the structural position of a property, and proximity of gas caps and edge-water lines will also have an important bearing upon the spacing of wells for most efficient drainage.

These are all physical variables, factors prescribed by Nature over which the oil producer has little or no control. Equally important are the economic factors to be discussed in the next article of this series, scheduled for an early issue of *The Petroleum Engineer*.

Bibliography

1. "A Discussion on Some of the Factors Affecting Well Spacing," F. M. Brewster. *A.I.M.E. Petroleum Development & Technology, 1925*, pp. 37-46.
2. "Economic Spacing of Wells," M. G. Cheney. *A.A.P.G. Bulletin*, Vol. 19, No. 6, January, 1935, pp. 876-899.
3. "A Study in Well Spacing, Sinclair-Moren Pool, Young County, Texas," M. G. Cheney. *A.I.M.E. Petroleum Technology*, November, 1940, T.P. 1253.
4. "Drainage Radii of Wells in East Texas," R. S. Christie. *A.P.I. Production Bull. 209*, pp. 20-21. (1933.)
5. "Equilateral Triangular System of Well Spacing," C. S. Corbett. *A.I.M.E. Petroleum Development & Technology, 1930*, pp. 167-173.
6. "Relation of Drilling Campaign to Income from Oil Properties," W. W. Cutler. *U. S. Bureau of Mines, R.I. 2270*, August, 1921.
7. "Estimation of Underground Reserves by Oil Well Production Curves," W. W. Cutler. *U. S. Bureau of Mines Bull. 228* (1924). See particularly, pages 85-90 on well spacing.
8. "Spacing of Oil Wells," L. L. Foley. *A.I.M.E. Petroleum Development & Technology, 1938*, pp. 15-24. See also, *The Oil Weekly*, October 11, 1937, p. 100.
9. "The Economics of Overdevelopment," J. D. Gill. *A.I.M.E. Petroleum Development & Technology, 1940*, pp. 206-213. See also, *Petroleum Technology*, August, 1939, T.P. 1084.
10. "Profits and Proper Spacing of Wells," W. P. Haseman. *Oil & Gas Journal*, October 18, 1928, pp. 53, 321-322.
11. "A Theory of Well Spacing, W. P. Haseman. *A.I.M.E. Petroleum Development & Technology, 1930*, pp. 146-156.
12. "A Formula Method for Well Spacing and Rate of Production," W. P. Haseman. *National Petroleum News*, May 8, 1929, pp. 59-65, and June 5, 1929, pp. 63-65.
13. "Effect of Well Spacing on Ultimate Recovery in the Santa Fe Springs Field," A. S. Hayes. *A.P.I. Production Bull. 209*, p. 19 (1932).
14. "Analytical Principles of the Production of Oil, Gas and Water from Wells," S. C. Herold. Stanford University Press, 1928.
15. "Oil-Well Drainage," S. C. Herold. Stanford University Press, 1942.
16. "Problem of Well Spacing," Houston Geological Society Study Group. *A.A.P.G. Bulletin*, Vol. 26, No. 1, January, 1942, pp. 100-122.
17. "Economics and Well Spacing in Texas," W. E. Hubbard. *A.I.M.E. Petroleum Development & Technology, 1937*, pp. 163-171.
18. "Optimum Spacing of Dolomite Acreage in the Texas Panhandle," P. J. Jones. *A.P.I. Production Bull. 225*, pp. 12-23. (1940.)
19. "The Future of Well Spacing," D. R. Knowlton. *Oil & Gas Journal*, Vol. 35, No. 52, p. 78. See also, *The Oil Weekly*, Vol. 85, No. 10, p. 51. May 17, 1937.
20. "The Geologist and the Well-Spacing Problem," E. Kraus. *A.A.P.G. Bulletin*, Vol. 22. No. 10, p. 1440. (1938.)
21. "Comparison of Spacing Problems in Gas Drive With Those in Water Drive Pools," J. O. Lewis. *A.I.M.E.* paper printed in *Oil & Gas Journal*, October 11, 1934, pp. 38-39.
22. "Relation of Gas-Well Spacing to Ultimate Recovery," D. T. MacRoberts. *A.I.M.E. Petroleum Development & Technology, 1938*, pp. 146-158. See also, *Petroleum Technology*, February, 1938, T.P. 868.
23. "Evils Attending Unnecessary Drilling in Proven Fields," Report of the Sub-Committee of Nine, Independent Petroleum Association of America. *Independent Monthly*, January, 1937. See also, *The Oil Weekly*, December 28, 1936, pp. 28-34.
24. "Review of Cutler's Rule of Well Spacing," H. C. Miller and R. V. Higgins. *U. S. Bureau of Mines, R.I. 3479*. (1939.)
25. "Principles of Well Spacing," M. Muskat. *A.I.M.E. Petroleum Development & Technology, 1940*, pp. 37-56. See also, *Petroleum Technology*, August, 1939, T.P. 1086.
26. "Well Spacing in the Bradford Field," K. B. Nowels and N. E. Maxwell. *A.P.I. Bull. 210*, pp. 101-103, December, 1932.
27. "Analytical Principles of the Spacing of Oil and Gas Wells," R. W. Phelps. *A.I.M.E. Petroleum Development & Technology, 1928-29*, pp. 90-103.
28. "Well Spacing As an Economic Factor in Development," R. W. Phelps, a series of papers published in *Petroleum World*, 1930.
29. "The Relation of Oil Recovery to Well Spacing," R. W. Phelps. *A.P.I. Bull. 210*, pp. 93-100. (1932.)
30. "Economic Aspects of Drilling," J. E. Pogue. *A.A.P.G. Bulletin*, Vol. 22, No. 6. June, 1938, pp. 633-644.
31. "Some Considerations Affecting the Spacing of Oil Wells," M. A. Rhys-Pryce. *Journal Institution of Petroleum Technologists*, October, 1934, pp. 951-972.
32. "Spacing of Wells in the Long Beach Field," D. C. Roberts and S. Sweeney. *A.I.M.E. Petroleum Development & Technology, 1930*, pp. 156-159.
33. "How Important Factors Influence Well Spacing," K. C. Sclater. *The Petroleum Engineer*, December, 1931, pp. 14-16.
34. "Well Spacing and Rate of Production Important Ultimate Recovery Factors," S. F. Shaw. *Oil & Gas Journal*, March 21, 1935, pp. 17-18.
35. "Some Consequences of Close Spacing in Kansas," E. A. Stephenson. *A.P.I. Drilling & Production Practice, 1938*, pp. 8-19. See also, *The Oil Weekly*, June 27, 1938, p. 25.
36. "The Well-Spacing Problem — Low Well Density Increases Ultimate Recovery," J. R. Suman. *A.P.I. Drilling & Production Practice, 1934*, pp. 158-166.
37. "The Elements of the Oil-Well Spacing Problem," L. C. Uren. *A.A.P.G. Bulletin*, March-April, 1925, pp. 193-216.
38. "Factors Governing Economic Spacing of Wells," L. C. Uren. *National Petroleum News*, November 27, 1929.
39. "Theoretical Aspects of Well Spacing," L. C. Uren. *National Petroleum News*, January 1, 1930, pp. 49-58.
40. "The Spacing of Oil Wells: Field and Experimental Data," L. C. Uren. *National Petroleum News*, March 19, 1930, pp. 78-84, and March 26, 1930, pp. 61-64.
41. "Petroleum Production Engineering — Oil Field Development," L. C. Uren. McGraw-Hill Book Co., New York, N. Y., 1934. See particularly pages 86-93 on well spacing.
42. "Experimental Study of Pressure Conditions Within the Oil Reservoir Rock in the Vicinity of a High-Pressure Producing Well," L. C. Uren and E. J. Bradshaw. *A.I.M.E. Petroleum Development & Technology, 1932*, pp. 438-466.
43. "Hydrodynamics of Reservoir Drainage and Its Relation to Well Spacing," H. D. Wilde and T. V. Moore. *A.P.I. Bulletin 210*, pp. 83-90, December, 1932.
44. "Well Spacing in the Salt Creek Field," F. E. Wood. *A.I.M.E. Petroleum Development & Technology, 1930*, pp. 160-167.
45. "Remarks of the Chairman to the Group Session on Well Spacing," F. E. Wood. *A.P.I. Production Bull. 210*, p. 82. (1932.)
46. "The Problem of Well Spacing," F. E. Wood. *A.P.I. Production Bull. 209*, p. 14. (1932.)
47. "A First Approximation of Comparative Ultimate Yields of Oil With Varied Well Spacing," F. E. Wood. *A.P.I. Production Bull. 211*, p. 14. (1933.)
48. "A Method for Determining Correct Spacing of Wells With Special Reference to West Texas," A. Young. *The Oil Weekly*, May 1, 1931, pp. 26-29.
49. "Analysis of Rocky Mountain Well Spacing," J. J. Zorichak. *A.P.I. Production Bull. 209*, pp. 22-29. (1932.)
50. "Effects of Additional Wells on Ultimate Yield," J. J. Zorichak. *A.P.I. Production Bull. 210*, pp. 91-92. (1932.)

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WORLD'S DEEPEST PRODUCER *Cameron-ized!*

WORLD'S DEEPEST OILER COMPLETED ON PELICAN COAST

By Associated Press.

Baton Rouge, June 17.—Oil explorers in the DeLarge field of Terrebone Parish have drilled more than 2½ miles into the earth, to set a new world record for depth of an oil producer.

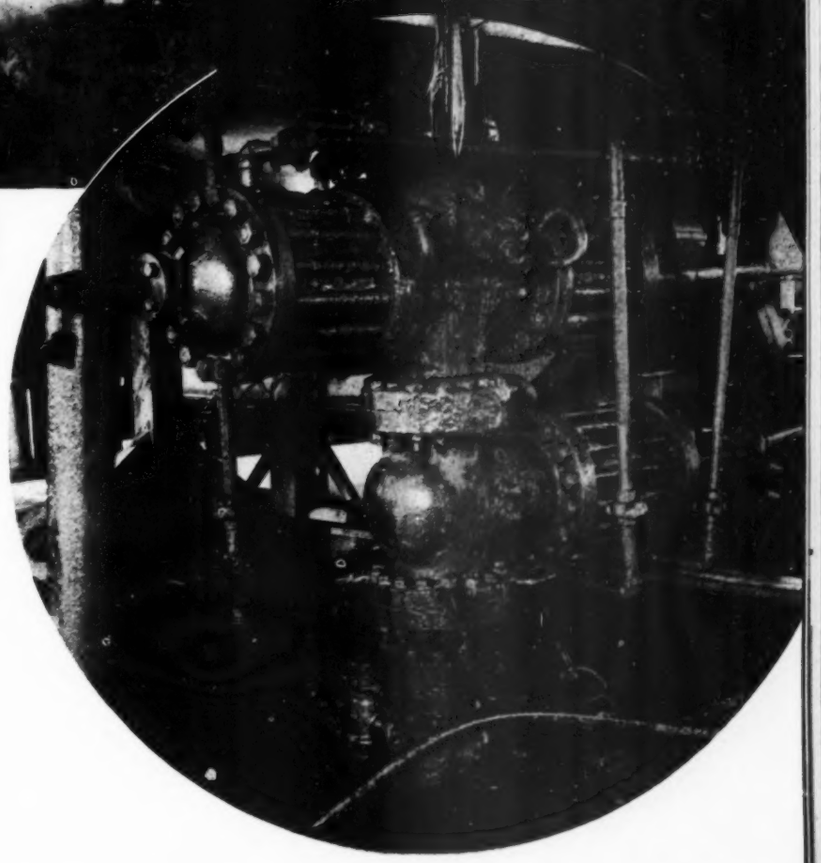
The first world record was set by the South Louisiana field's discovery well, which was completed at 13,265 feet, several years ago, to give Louisiana the deepest producer.

The new well, Union Producing Company's No. 1 Fitzpatrick-Vizzard, was brought in through perforations at 13,457 to 13,490 feet.

It was classed, unofficially, as a gas-distillate well, and a state potential test was awaited.

The No. 1 Fitzpatrick-Vizzard was said to have opened a northeast extension of the field, and maybe a new producing horizon.

Preliminary tests made through a 3/16-inch bottom hole choke and a ¼-inch top hole choke showed



No. 1 Fitzpatrick-Vizzard, DeLarge field, Terrebonne Parish, Louisiana. (Right) Cameron 6000 lb. test drilling control units—Type SDA Pressure-operated Blow-out Preventer and Type DV Pressure-operated Gate Valve.

No. 1 Fitzpatrick-Vizzard, drilled jointly by Union Producing Co. and the Fohs group—DeLarge Oil Co., Fohs Oil Co., and Foroy Petroleum, Inc., and recently completed at a depth of 13,457-13,490 feet in the DeLarge field of Terrebone Parish, Louisiana, is the new depth record holder, exceeding by 225 feet the depth of the previous deepest producing well, Buckley-Bourg No. 1, also located in the DeLarge field.

Drilling to such extreme depths in this semi-marine field, an operation complicated by the marshy terrain and the ever-present high gas pressures, deserves the plaudits of the entire industry.

That Cameron Pressure-Operated Drilling Control Units were selected to protect the substantial investment in these unusual wells is testimony to the confidence placed in this equipment by the industry as a whole.

Operators who are planning deep exploratory wells are urged to weigh carefully the numerous exclusive mechanical advantages provided by Cameron Pressure-Operated Drilling Control Units and to bear in mind that no well, equipped with Cameron drilling control units of adequate test pressure, has ever been lost due to failure of the drilling control equipment.

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P 978.
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Wartime Safeguards for Petroleum[1]

☆ Government and industry have combined efforts to protect against subversive activities

by Frank A. Epps[2]

IT has been remarked by some commentators that we are engaged in a war primarily for oil and with oil. Clearly, one of the objectives of the Axis Nations has been to acquire petroleum resources. Certainly, the war will not be won without oil and plenty of it. The United Nations depend on us. American refineries are the principal source of high-octane aviation gasoline. American oil fields are the source for the greater part of the entire Allied oil supply. Petroleum products from our own oil wells supply the driving power for British bombers over Europe, American planes in Africa, Soviet aircraft from Rostov to Leningrad, General Sherman tanks in Tunisia, and American Air Forces in China. Our battleships, warcraft, and transports are fueled with petroleum; our war factories could not run without its lubricants. It is a staggering burden, and our resources to supply this huge war demand are being taxed to the utmost.

The safeguarding and protection of this vital supply is obviously of paramount importance. Continuity of production, refining, and transportation of petroleum in ever-increasing volumes must be assured. The synthetic rubber now being produced from petroleum in an almost unbelievable new industry is still another story of the part being played today by the petroleum industry in the conduct of this gigantic war of survival of the fittest.

It is well known and recognized that the Axis Nations have for years been creating, training, and developing a most colossal program for sabotage and subversive activity. Their agents have received long and painstaking instruction in the operation and use of every devilish device for destruction ever conceived by the human mind and, without doubt, many new instrumentalities as yet unknown to us have been added to their bag of tricks. They have become skilled in the technique of penetration and they have burrowed into our midst over a period of years, setting themselves up as loyal, God fearing and respected members of our communities. The imminence of their threat is very real, and the importance of counter-active measures is self evident.

FRANK A. EPPS

was graduated from the University of Pennsylvania in mechanical engineering, 1916—From 1916 to 1922 was chief engineer, production manager, and director of the Foamite Fire Extinguisher Company—Became affiliated with Tide Water Oil Company as manager of its Fire Protection Department—Subsequently was special assignment engineer, chief engineer of Marketing Division, and operating manager of the same Division—Went with Gulf Oil Corporation in 1935 as superintendent of operations of New York Division, and in 1940 formed the Spartan Oil Company, of which he was president until joining PAW in 1942.

Fortunately for us, we have had in this country a most efficient and well-organized agency—the Federal Bureau of Investigation. This organization has performed a splendid service. The full extent of their achievements in uncovering and stifling plots of subversive nature will probably never be known. It is not to be assumed, however, that all or even a large part of those who conspire against us have been rounded up. We have good reason to believe that there are thousands still at large in our industries.

To supplement the splendid work of the Federal Bureau of Investigation, an Army Program of Internal Security was created immediately after the outbreak of the war and all units of industry receiving contracts for the production of war materials were placed under the supervisory guidance of Army personnel in effecting measures required for the safeguarding and protection of the facilities used for the production of war materials. The properties so involved were placed upon a so-called "Army Master Responsibility List." This list included a number of the most essential petroleum properties.

There were many other properties and facilities, likewise essential to the war effort, not set forth on this list and, hence, the President in his Executive Order 9165 dated May 19, 1942, created an auxiliary program of internal security to be supplementary to and correlated with the Army's program. The Office of Civilian Defense was designated as the coördinating and correlating agency and the security activities to be initiated thereunder were divided among about a dozen different participating Federal agencies, one of which was the Department of the Interior in relation to its jurisdiction over certain natural resources and petroleum. There was then created within the Office of Petroleum Coördinator (subsequently recast as the Petroleum Administration for War), a Facility Security Division, which was charged with the responsibility of making security surveys of the unassigned properties essential to the war effort engaged in the production, manufacture, and distribution of petroleum and its products. These surveys were to be made for the purpose of determining deficiencies in protective measures so as to point the way to circumvention of attempted subversive acts and control of fire, the principal weapon of the saboteur. In addition, to protect the plant and its personnel from the consequences of acci-

[1]Presented before National Fire Protection Association, Chicago, Illinois, May 12, 1943.
[2]Director, Facility Security Division, District 1, Petroleum Administration for War.

If He Could Look Back
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Wyatt 225-gallon galvanized corrugated wagon tank.

Thirty years ago W. J. Wyatt fashioned storage and wagon tanks from galvanized iron in a small shop at Dallas, Texas. Truly he was a pioneer industrialist in his line. With a few ambitious workers, a few shop tools and some good ideas he laid plans for bigger things to come.

Today 1200 skilled craftsmen in Wyatt's Houston and Dallas plants are fabricating those bigger things. Backed by all that modern science offers in machines and methods, they are turning out pressure vessels in train-load lots for processing aviation gasoline, toluene, butadiene, ammonia, magnesium, powder, glycerine and other products vital to victory. Rolled from steel plate, these vessels measure up to 14 feet in diameter, to 165 feet in length, to 475,000 pounds in weight. Many require three special railroad cars to transport. All are stress-relieved, and radiographed to insure faultless fabrication. Wyatt Metal & Boiler Works, Houston and Dallas.

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dental fire and accident, a prevention program in these two categories was to be included. It was held, and rightly so, that loss of facility and product by accidental fire or damage would be equally in the interest of the Axis Nations as if the same effect were obtained by sabotage. Recommendations resulting from the surveys were to be submitted to the property owner, as it was determined that the owner or operator was primarily responsible for the maintenance of security of facilities within his own jurisdiction.

This Division was charged further with the responsibility of making recurring inspections, as needed, to ascertain progress made in correcting deficiencies and noting any new conditions that might have arisen.

Executive Order 9165 contained no provision for the enforcement of recommendations because the onus of primary responsibility through ownership remained with the plant management. I am happy to say, at this point, that the petroleum industry has been tremendously coöperative. Thus far about 90 percent of the recommendations made by this Division have been complied with and the remainder are either in process, or have been modified by mutual agreement with management, to the extent that acceptable alternative methods accomplishing the same result have been approved.

The Facility Security Division of the Petroleum Administration for War was staffed almost entirely by experienced engineers from within the industry who had previously had specialized training in the subject of plant protection.

You are all aware, of course, that the oil industry, because of its special fire hazards, has been actively alert for a period of many years in the practices of fire protection and accident prevention. Your speaker has served on your Flammable Liquids Committee in this respect for nearly 20 years as the representative of one of the oil trade associations. Others associated with me in this activity have had similar backgrounds, either in the technical or operating units of their respective companies.

Because of my long interest in fire prevention activities, it has been very gratifying to me to be placed in a position to observe the splendid progress made by the oil industry in safeguarding its operations. Before the outbreak of the war this industry was well advanced in its conception of standards and requirements for the protection of its own properties and those nearby. This happy state of affairs has made our own job much easier because the major items have already been cared for. Thus, we have found that simple correctives, which do not involve to any appreciable extent the use of critical materials and manpower, have been usually fully adequate to meet the situation.

Some of you may have wondered to what extent the mounting production of certain types of war petroleum products have increased fire hazards within the industry. I have had various conversations with men in the fire insurance field who have been very concerned, for instance, with the increased storage of 100-octane aviation gasoline. When the layman mentions this superfuel, he immediately imagines a gasoline possessing extremely high volatility. Many people have the preconceived notice that "high-octane" is synonymous with light gravity, volatility, and "high test." I wish to take the time here to point out that this conception of aviation gasoline is entirely false. The product is high in anti-knocking characteristics, and for that reason it is truly a super-fuel, but its volatility is far less than motor gasoline. In comparing this product with motor gasoline, if tendency to form vapors is a criterion of fire risk, the hazards connected with the storage and handling of aviation gasoline are far less than they are for motor gasoline. As technical men, you can well understand that aviation gasoline must still remain a liquid when the planes using it are operating in the stratosphere in an environment of considerably reduced atmospheric pressure. If motor gasoline were used at these high levels, the reduced air pressure would lower the boiling points and produce vapor-lock in the carburetors and fuel distributing systems. It therefore follows that aviation gasoline must of necessity become a relatively stable commodity at ordinary atmospheric pressure in comparison to motor gasoline. In a similar way, the production of butadiene for synthetic rubber, toluol for explosives, and other war products produced from petroleum do not create any additional, or new, fire hazards, the safe control and handling of which is not already known to the oil industry. Many of them are safer relatively than other petroleum products well known to you, which are safely handled day in and day out.

The fire hazards in the petroleum industry and the methods of controlling them vary greatly from the hazards and procedures commonly associated with the usual type of industrial fire risk. Your association has evolved through the years in no small measure around the use of automatic water sprinklers and the various techniques employed in handling fires in ordinary combustibles. Automatic sprinklers are almost unknown in the petroleum industry and their use is not to be advised or recommended except in certain rare cases of building occupancy and construction. I mention this merely because some inspectors with fire insurance inspection backgrounds employed by certain branches of the services have "gone overboard" in recommending the use of automatic water sprinklers in oil properties. Not only is this most often specifically inadvisable in oil properties, but if installed would involve the use of critical materials that could be employed otherwise to far better advantage.

At this time I would like to tell you of a new and recent development in the Federal Security Program insofar as it relates to oil properties, in which I believe you will be interested. About two months ago, an agreement was reached between the Office of Provost Marshal General and the Facility Security Division of P.A.W. to the effect that subsequent inspections of oil properties on the Army's Master Responsibility List would be conducted on a joint basis by representatives of the Service Commands and the Facility Security Division of P.A.W. The jurisdiction of the Army Air Force over certain of the petroleum plants producing aviation products was transferred to the Service Commands. The net result of this agreement is that the multiplicity of agencies concerned with security in petroleum properties has now been centralized in one joint operation between ourselves and the Army on the most important plants. Our specialized technical knowledge has been combined with the military and intelligence prerogatives and powers of the Army. This arrangement is now operating, I believe, very satisfactorily to all concerned although the state of transition has not yet been fully completed. Our Division, however, is continuing as the sole security agency for oil properties not assigned to the Army as originally contemplated under Executive Order 9165.

In closing, I have attempted to tell you briefly about the organization of this important work. From a personal viewpoint I find that this activity has been intensely interesting and I should add that there has been a good bit of hard work along with it. It has been very helpful to me in undertaking the assignment to have had the background of long years of membership and acquaintance in this association. I have received a great deal of helpful coöperation from many of our members, which I gratefully acknowledge. The procedures and standards that you have developed over a long period of time have simplified the task, and they have performed a valuable basis of guidance, without which the policies of this undertaking could not have been established so soundly in a short period.

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VICTORIA, TEXAS	TYLER, TEXAS	LAKE CHARLES, LA.	CASPER, WYOMING	AVENAL, CALIF.

Refinery Use of Joint-Sealing And Anti-Seize Compounds[1]

☆ **Special attention to construction and maintenance problems by manufacturing and construction organizations can save many hours down-time**

JOINT-SEALING problems in refinery construction and maintenance are innumerable. Such problems are of interest to the manufacturers of refinery equipment, construction engineers, and superintendents, as well as to maintenance men. Some special attention to these problems by manufacturing and construction organizations will speed construction, make the work of the maintenance men much easier, and save many hours of down-time. Essentially, the problem is the same whether it concerns pumps, valves, heat exchangers, pipe lines, or other equipment.

Despite the improvements in thread-cutting tools and machinery, no two pipe threads, studs, bolts, or screws are cut exactly alike. Male and female threads of a pipe joint are cut with separate tools. An allowance or tolerance is established to obtain a "perfect fit." Most types of joints are cut on a taper. When the pipe joint is assembled, a jamming action is created. This friction generates heat. If the temperature created is high enough, the metal parts tend to fuse, or seize.

Many types of pipe-joint "dopes" have been developed for the purpose of sealing joints tight against leakage. If a compound eliminates leakage then it is a good joint-sealing compound. To be an anti-seize compound also, the joint sealing compound must have additional properties. A compound that reduces the torque required to break-out a pipe joint, stud, or bolt is called an anti-seize compound. The torque required to disassemble should not be more than the torque required to assemble.

A stud that shears off on a pump or boiler means additional labor cost spent in drilling or cutting out the stud, additional down-time, and additional material cost. Added to these items today is the difficulty of procuring replacement parts. Crystallization may cause a stud to shear off after long service; however, a proper anti-seize compound will double or triple the life of studs.

Lubricating oil or mixtures of lubricating oil and graphite ordinarily are used on stud threads. These may not reduce to a sufficient extent the friction created during makeup. For joints, studs, or bolts that must endure high temperature, soap or molasses compounds may also be insufficient. They evaporate or carbonize, leaving channels in the threads so that air and moisture enter and corrosion takes place.

A compound should lubricate the threads as the joint is being made up, enabling the threads to be cold drawn together in tightening. Thus the threads are drawn into perfect alignment. By reducing friction the temperature is kept low, preventing fusion of the threads. The fittings can be made up to their maximum points and a tight shoulder-to-shoulder contact established.

A compound should neither separate, harden, nor soften under variations of operating conditions, but should provide a leak-proof joint on lines carrying air, gas, oil, water, steam, ammonia, alkalis, hydrocarbons, chlorides, or other chemicals.

A compound should be such that it can be applied easily with a brush and the container or can remain open for any length of time without causing a change in the material.

Use in Refinery Maintenance

In refineries leaks must be avoided on connections to gauges, meters, and thermometers. Disconnections for repair and calibration are thereby greatly facilitated.

When installing refrigeration units that use ammonia as a refrigeration gas, the general practice has been to use litharge and glycerine as the joint-sealing compound. The litharge and glycerine are usually purchased separately and mixed when needed; this mixture must be used immediately to prevent hardening in the mixing can. When a jointed line is made up with this compound, no one joint in the line can be broken out without breaking out and reassembling all these hard set joints.

Ammonia line joints should be made up with a compound that will stand severe vibration without leakage, so joints will break out individually without disturbing others.

For use in the assembly of water-treating, filtration, and catalyst-reclamation units, as well as for the joints in condenser systems, sludge pumps, settling and storage tanks, a compound that is water-resistant should be used. It should maintain a tight, leak-proof joint under maximum refining temperature conditions if it is to be suitable for use on the studs and connections of high-pressure tanks and kettles.

Fuel oil burners are subjected to continual high temperature and fuel pressure. Leakage of the joints results in decreased atomization, a waste of fuel, and consequent lowered burner efficiency. It is well to use the proper compound on the preassembled burner and its threaded joint to the fuel line. The same is true for bolts, studs, and connections on preheaters, and heat-transfer units, as well as for steam, Diesel, and gasoline engines.

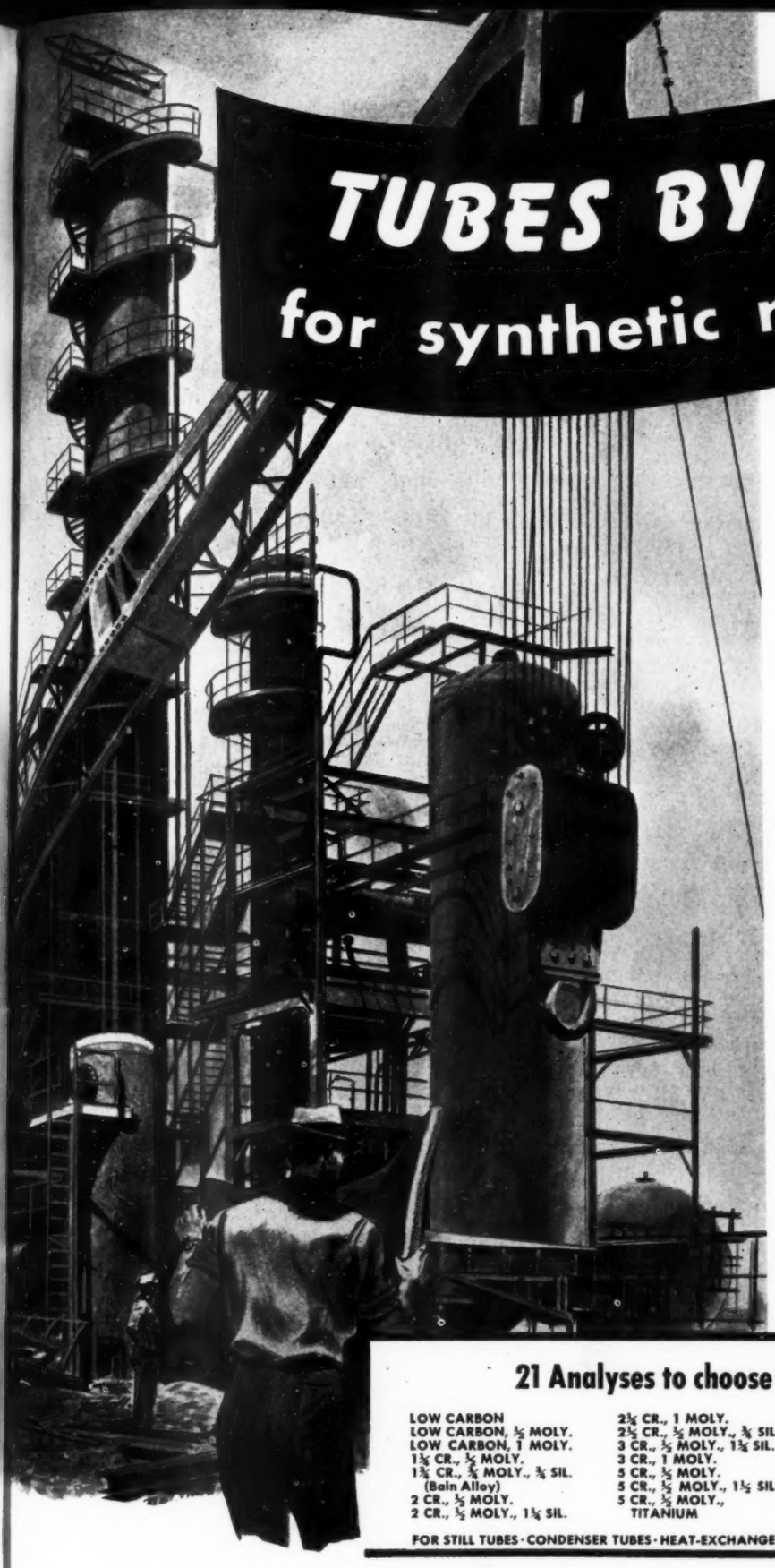
In air-conditioning units a compound with the proper heat and moisture-resistant properties is most helpful, easing assembly and take-down. In the pipe shop a compound, if of the proper kind, is of value in bending, as it will act as a drawing compound to prevent scuffing by the bending tools. Used as a dressing on wire cables a good compound prevents internal friction of the wires against each other, adding to the period of service. Used on cylinder-head or pump-head studs or bolts, it makes a smooth, even draw-up, thus minimizing the danger of cracking the cylinder head.

Heavy gears in outdoor service do well with a water-resistant lead compound as a lubricant. The finely divided lead particles are coated with a strong film of the suspending medium, resulting in a lubricant that withstands heavy loading and lengthens the life of the gears. When pneumatic impact wrenches are used in assembly, such a compound on the studs gives smoother operation, with greatly increased facility of takedown.

Valves

A. Seat rings. There are two usual

[1]Compiled by the Engineering Department I. H. Grancell Company, 1601 East Nadeau Street, Los Angeles, California, specialists in the development and manufacture of joint-sealing and anti-seize compounds.



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Time is the all-important factor to consider today—and that's where we can help you most. There's no need to lose valuable days or weeks in determining the proper tube. Our metallurgical staff can help you make the right selections without delay. They know metals and how they will stand up under the various elements used in making synthetic rubber.

Once we have the proper "go ahead," our plants will turn out the tubes in the shortest possible time. On top of this, a NATIONAL Seamless Tube *itself* will save time. It is easy to fabricate, welds readily and has uniform wall thickness. Workmen find they can install more footage before the quitting whistle blows.

Send for this Book

A helpful book entitled "Technical Data for Refineries" gives specifications and properties of each type of steel tube needed for the industry. You can find a world of information on properties at elevated temperatures, corrosion resistance, forging properties, welding practices and the most important applications. It also contains a chart showing comparison of the various types of steel for chromium content, relative cost, tensile strength, creep stress, oxidation susceptibility, Brinell hardness and lineal thermal expansion. Send for a copy today.

21 Analyses to choose from*

LOW CARBON
LOW CARBON, ½ MOLY.
LOW CARBON, 1 MOLY.
1¼ CR., ½ MOLY.
1¼ CR., ⅜ MOLY., ⅜ SIL. (Bain Alloy)
2 CR., ½ MOLY.
2 CR., ½ MOLY., 1¼ SIL.
2¼ CR., 1 MOLY.
2½ CR., ½ MOLY., ⅜ SIL.
3 CR., ½ MOLY., 1¾ SIL.
3 CR., 1 MOLY.
5 CR., ½ MOLY.
5 CR., ½ MOLY., 1½ SIL.
5 CR., ½ MOLY., TITANIUM
5 CR., ½ MOLY., COLUMBIUM
7 CR., ½ MOLY.
8 CR., 1 MOLY.
17 CR.
18-8
18-8, TITANIUM
18-8, COLUMBIUM

FOR STILL TUBES · CONDENSER TUBES · HEAT-EXCHANGER TUBES · REFINERY PIPING

*During the present emergency the Office of Petroleum Coordinator has recommended to refineries that orders be confined to a limited number of alloy classifications. It will be understood, therefore, that the 21 analyses shown are given as a matter of engineering information, and that some of these alloys may not be available during the period of restrictions.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

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UNITED STATES STEEL

types of valve seat rings, the screwed-in type and the pressed-fit type.

Lead seal compound should be applied to the threads of a threaded seat ring. The ring can then be tightly assembled without danger of the fluid cutting into the threads and causing leakage through them.

A lead seal compound can also be used as a lubricant on a pressed-fit type seat ring before forcing the ring into place. This type of ring is thereby tightly sealed against leakage and it is possible to remove the ring for replacement if the seat wears out.

B. Disks. Some types of valve disks are screwed on to the stem. Others are made of various compositions depending on the service and are assembled with a retaining nut on a disk holder. The proper compound on the threads in tightening up this nut will assure a tight assembly.

C. Bonnets. Valve bonnets are of three types, screwed, union, or bolted. In assembling the screwed and union bonnets, suitable compound should be used on the threads to seal the joints against leakage. Use of a non-hardening compound permits easy disassembly for inspection or cleaning of the internal valve parts when necessary.

Bonnets of large valves are assembled with bolts or studs. Use of a compound on the threads of the bolts or studs enables a mechanic to tighten the nuts evenly and reduces the danger of creating too much tension on any one or more of the bolts or studs.

A ring gasket of soft steel is used to seal many of these bolted bonnets. Application of lead seal compound to the ring before assembly helps the steel to flow and aids in creating the seal during assembly.

D. Packing glands and yokes. Valve packing gland yokes should be assembled in the same manner as bonnets outlined previously.

Salt Spray and Moisture

Seized or "frozen" joints, studs, or bolts may be due to any of the following causes:

A. Improper mating of the threads.
B. Friction of assembly generating high temperature and causing fusion.
C. Exposure to high temperature during service.
D. Corrosion or rust.

Any or all of these may occur simultaneously. Salt water spray accelerates corrosion. It not only attacks exposed threads of pipe fittings, studs, and bolts but also gets into the joints. The resulting corrosion makes it impossible to break-out joints, studs, and bolts even after short periods of service. Using a torch or a hammer may cause irreparable damage to the parts.

A protective coating of paint may be given a pump, boiler, valve, or pipe line to minimize this corrosive action but if the threads of joints are painted, it may prove troublesome. Anti-corrosive compounds are excellent for exterior surfaces, but are usually unsatisfactory for pipe threads.

Applying oil or grease to the threads will give them protection against corrosion for only a short period of time, particularly if the joints are subjected to high temperature.

A proper joint-sealing and anti-seize compound will provide protection against corrosion not only of the threads in the fittings but also the exposed threads.

To test a compound apply some of the compound to a joint, make it up tightly, then place the joint in a salt water tank for a few days. Place the joint in a vise and break it out: notice first the ease of disassembly; second, examine the condition of the threads under a magnifying glass.

Although corrosion due to moisture causes most trouble with fittings in refineries in coastal areas, the same problem is present in inland refineries.

High Temperature Conditions

Many pipe joints, studs, and bolts in refinery service are subjected to high temperature for long periods of time. These joints may have to be broken out at intervals for internal cleaning of equipment or for other reasons. The melting point of metallic lead is 720° F. Many times the question has arisen, how can a lead compound be used under service temperature above 720°F? The compound is applied to the threads of a joint and the joint is made up tightly. Although the compound may melt, it cannot run out of the joint. After the necessary period of service, when it is desired to break out the joint, there remains a film of the compound between the metal threads. It might be called a lead gasket. This film does not alloy with the threads. It prevents the fusion of the metals that might otherwise take place at high service temperature.

This film or lead gasket between the threads makes it possible to break out the joint without use of an appreciably higher torque than that with which the joint was made up. The film is very thin. After breaking out the joint, the film may only be seen by examining the threads under a magnifying glass or scraping the threads with a knife.

High Pressure Conditions

Many refinery lines carry gas, hot oil, or other liquids under pressure of 700 lb. per sq. in., or higher. Considerable leakage trouble is experienced particularly with hot oil lines. Leakage also results in handling superheated steam under high pressure.

If lead seal compound is applied to the threads of the joint and the joint is assembled tightly, it will hold hot oil, steam, or any refinery chemical without leakage. This is true even in the case of lines that are subjected to continual vibration.

The information in this article is applicable not only to the construction and maintenance of refineries but also to the construction and maintenance of natural gasoline, cycling, gas, and chemical plants.

☆ ☆ ☆

About 10,000 Women Working in Refineries

About 10,000 women are employed in all types of work in petroleum refineries in the United States, and many more will be hired before the war is over, Deputy Petroleum Administrator for War Ralph K. Davies revealed recently.

Urging U. S. refiners to keep up their production of petroleum products by hiring women to supplant the men who are called to the armed forces, Davies said:

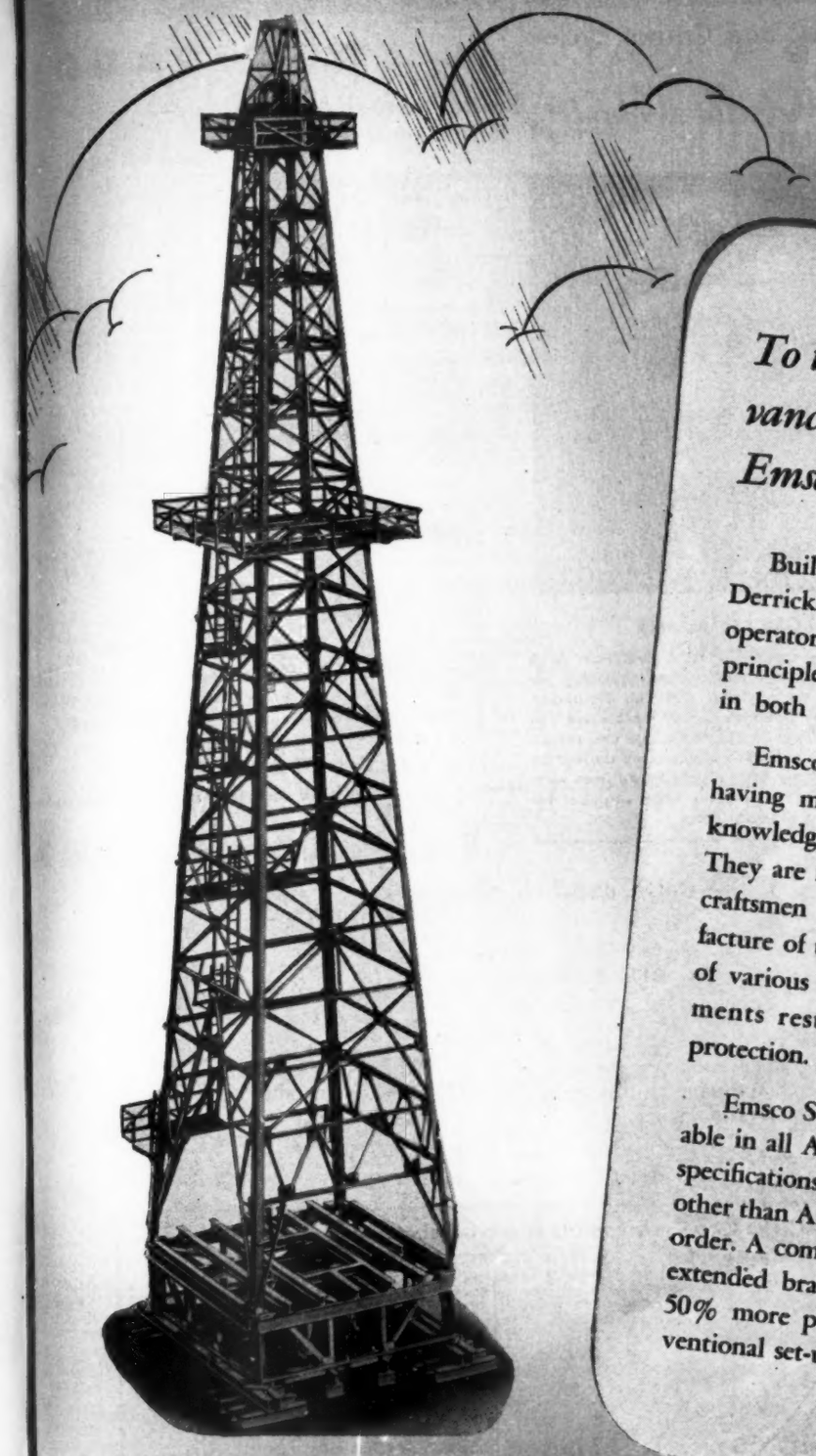
"Experience has shown that women can do and are doing excellent work in refineries throughout the country. Despite the fact that the petroleum industry is losing many skilled workers to the draft and to other types of employment, it is essential that there shall be no reduction in the processing of petroleum products because of lack of manpower.

"Recent studies indicate that, by approaching the problem carefully, the number of jobs which cannot be assigned to women is much less than would appear at first glance."

The Deputy Administrator referred to a study conducted at the request of PAW by the Bureau of Labor statistics of the Department of Labor.

In 74 refineries in which the study was conducted 27,646 persons were employed, of whom 2,627 were women. Of this group 856 women worked on refinery operations, 39 on maintenance, 477 in laboratories, 1,156 in offices, and 99 on other types of work.

For Those Operators Who Know That Only The BEST Is Good Enough



To those familiar with modern, advanced oil field equipment, the name Emsco carries a great significance.

Built to standards singularly high, Emsco Steel Derricks have gained the unqualified approval of operators and rig builders alike by virtue of sound principles of design plus outstanding performance in both domestic and foreign fields.

Emsco Derricks are designed by trained engineers having many years of experience and a thorough knowledge of drilling and production requirements. They are fabricated in Emsco's own shops by skilled craftsmen particularly qualified through the manufacture of thousands of rigs and auxiliary equipment of various types. They embody advanced improvements restricted to Emsco products by patent protection.

Emsco Steel Derricks and Substructures are available in all A. P. I. sizes and adhere strictly to A. P. I. specifications. Derricks and substructures to meet other than A.P.I. specifications are available on special order. A complete line of Bulge Type Derricks, with extended bracing to accommodate from 33⅓% to 50% more pipe than can be racked with the conventional set-up, also is available.

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Basic Entropy Problems

Exclusive

☆ Illustrative calculations for Otto, Diesel, and Carnot cycles

by Orville Adams

THE usefulness of entropy in understanding and developing the Diesel engine may be shown by a few practical calculations. Considering the three basic cycles, the Otto, the Diesel, and Carnot's perfect cycle, each of which will take in a cylinder charge of 0.2 lb. at a pressure of 14.5 lb. per sq. in. abs., and at a temperature of 100°F. The charge is to have the following properties, which are not permitted to vary during the cycle: (a) $C_p=0.245$, (b) $C_v=0.180$, $k=1.361$, $R=50.57$, and (c) heat value of the charge = 100 B.t.u. The Otto cycle has a compression ratio of 5 to 1, the Diesel cycle a compression ratio of 14 to 1, and the Carnot cycle operates between the same temperature limits as the Otto cycle.

Problem: Determine the temperatures, pressures, entropy changes, and cycle efficiencies for (a) the Otto engine, (b) the Diesel engine, and (c) the Carnot engine.

Otto Cycle

Solution: Referring to Fig. 1, $p_a=14.5$, $T_a=560$°F. abs., and

$$\frac{V_b}{V_a}=r=5.$$

$$\frac{T_b}{T_a}=\left(\frac{V_a}{V_b}\right)^{n-1}=5^{0.361}=1.788$$

Therefore:

$T_b=560\times1.788=1001$°F. abs. or $1001-460=541$°F.

By definition:

$$\frac{p_b}{p_a}=\left(\frac{V_a}{V_b}\right)^{n}=5^{1.361}=8.95,$$

Therefore:

$p_b=14.5\times8.95=129.7$ lb. abs.

${}_aS_b=0$, as this is an adiabatic process.

${}_bH_c={}_wC_v(T_c-T_b)$

$100=0.2\times0.18(T_c-T_b)$

$$(T_c-T_b)=\frac{100}{0.036}=2778\text{°F.},$$

$T_c=T_b+2778=3779$°F. abs., or $3779-460=3319$°F.

$$\frac{p_c}{p_b}=\frac{T_c}{T_b}$$

$$\frac{p_c}{129.7}=\frac{3779}{1001}$$

$$p_c=129.7\times\frac{3379}{1001}=490\text{ lb. abs.}$$

$${}_bS_c={}_wC_v\log_e\frac{3779}{1001}$$

$=0.2\times0.18\times1.328$

$=0.04782$ units.

ORVILLE ADAMS

was recently commissioned a lieutenant (s.g.) in the U. S. Naval Reserve, relinquishing his position as an engineer with the Guiberson Diesel Engine Company, Dallas, Texas—He was educated at Kentucky State College and served in the technical branch of the army during the first World War—After his discharge from service he was for many years sales engineer for Diesel engine manufacturers.

$$\frac{T_c}{T_d}=\left(\frac{V_d}{V_c}\right)^{n-1}=5^{0.361}=1.788$$

Therefore:

$$T_d=\frac{T_c}{1.788}=\frac{3779}{1.788}=2111\text{°F. abs.}$$

or $2111-460=1651$°F.

It will be noted that the ratios or temperatures and pressures are the same, because the compression ratio is equal to the expansion ratio. Hence:

$$\frac{T_b}{T_a}=\frac{T_c}{T_d}\text{ and }\frac{p_b}{p_a}=\frac{p_c}{p_d}$$

By definition:

$$\frac{p_c}{p_d}=\left(\frac{V_d}{V_c}\right)^{n}=5^{1.361}=8.95$$

Therefore:

$$p_d=\frac{490.0}{8.95}=54.75\text{ lb. abs., or about}$$

40 lb. gauge.

Also:

$${}_dS_a=0.2\times0.18\log_e\frac{560}{2111}$$

$=0.360\,(-1.328)=0.04782$ units.

$$\text{Efficiency}=1-\left(\frac{1}{r}\right)^{n-1}$$

$$=1-\left(\frac{1}{5}\right)^{0.361}$$

$=1-0.559=0.441$, or 44.1 percent

Checking, heat rejected:

${}_dH_a={}_wC_v(T_d-T_a)$

$=0.2\times0.18\,(2111-560)=55.85$ B.t.u.

By definition:

$$\text{Efficiency}=\frac{\text{heat added}-\text{heat rejected}}{\text{heat added}}$$

$$\frac{100-55.85}{100}=44.15\text{ percent}$$

These steps involve the usual formula or equations used in such calculations.

The Diesel Cycle

Referring to the diagram of the Diesel cycle, Fig. 2, the values are as follows:

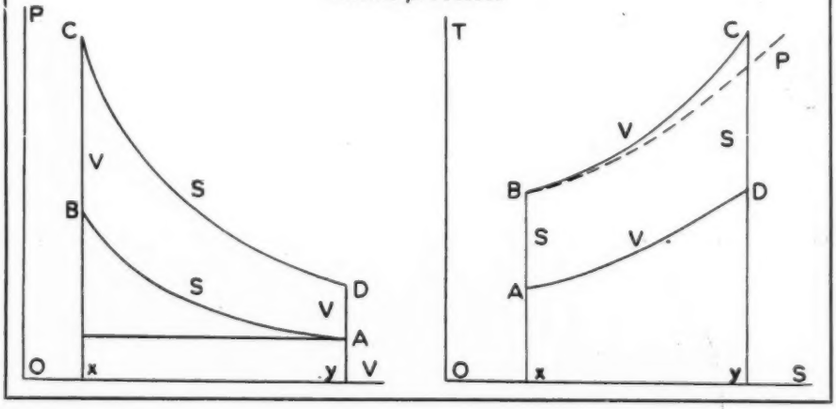
$p_a=14.5$ lb. abs.,

$T_a=560$°F. abs., and

$V_b/V_a=r=14$.

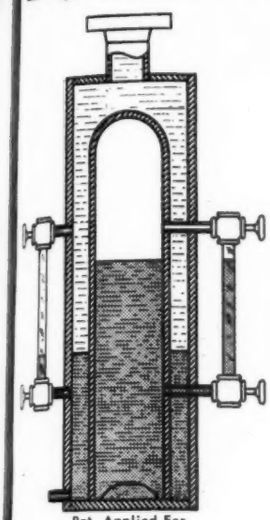
$$\frac{p_b}{p_a}=\left(\frac{V_a}{V_b}\right)^{n}=\left(14\right)^{1.361}=36.33$$

Fig. 1. The Otto Cycle consists of two adiabatics and two constant volume processes



When it Comes to Pipelines— Come to Wheatley

EQUALIZERS—Liquid Seal



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- Easily Installed
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- Nothing Wears—Nothing Tears
- Nothing to be Replaced
- Available for suction and discharge side
- Made in any size
  Available for Immediate Shipment

Outstanding features and efficiency proved by major pipe line under actual operating conditions.

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For Instance—

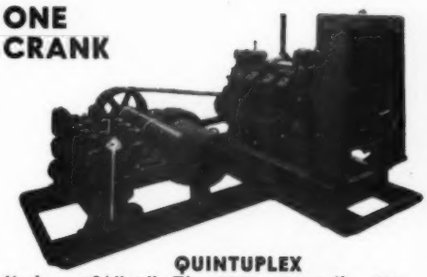
10 IMPULSES TO ONE REVOLUTION OF CRANK

LESS SURGE

LESS WEIGHT

MORE VOLUME

MORE PRESSURE



QUINTUPLEX

5 Cylinders, 5¾"x8", Fig. 5850—8300 lbs. Wt.

CAPACITY

Figure	Liner	Gal. Per Min.	Bbls. Per Hour	Pressure Per Sq. Inch	Max. H.P. Req'd
5¾" x 8"	3"	182	260	1605	200
V-Belt	3½"	257	367	1137	200
Fig. 5850	4"	344	492	850	200
Five Cylinder	4½"	442	632	658	200
85 R.P.M.	4¾"	495	707	590	200
Steel Fluid	5"	552	789	529	200
Cylinders	5½"	673	961	434	200
	5¾"	735	1050	396	200

DUPLEX

Power driven, reciprocating, with interchangeable liners, Herringbone gears Direct or V-Belt Driven.

2½" x 4" x 6"
2½" x 6" x 6"
2½" x 5" x 10"
2½" x 7" x 10"
2½" x 8" x 10"

Pressure from 190 lbs. to 1500 lbs. Capacities from 69 B.P.H. to 729 B.P.H.

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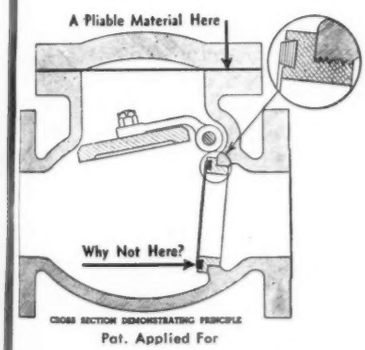
CHECK VALVES

—Exclusive Synthetic Rubber Seal



Pat. Applied For

Equipped with Wheatley Synthetic Seal—a synthetic rubber ring dovetailed and fitted into a removable bronze seat. A perfect seal is formed regardless of what irregularities have deposited on the seat or in the fluid, such as sand, scale and cuttings which under pressure ordinarily would completely cut out a hard surfaced seat.

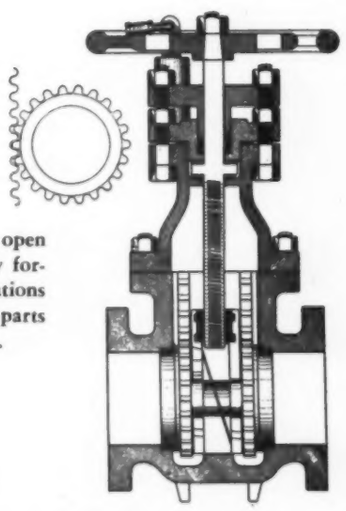
- The rubber ring conforms to all deposits and obstacles and makes it possible for this valve to seal under the worst conditions.
- Seals regardless of viscosity. Operates equally well on kerosene or crude.
- No lapping or grinding of seats necessary.
- Absolutely silent in operation. Ideal for refineries and pumping stations where the slapping of metal check valve clappers is annoying.
- Renewable bronze seat ring, into which the rubber ring is inserted, can be replaced by the standard metal-to-metal seat, if desired.

Write for Bulletin MP42

GATE VALVES

—Self-Cleaning Rack-Type

This Gate Valve is of the rack type construction which means the Gate Discs have teeth identical to gears and are so designed that they run up a rack (see diagram) which is cast in the body of the valve.



This construction makes it easier to open and close the valve and prevents any foreign materials from freezing the operations of the valve. The interior working parts are cast of Wheatley Special Bronze.

Made in Sizes 2" to 12"
Series 15- 30- 40- 60
Iron, Steel, Brass

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- RIVER CLAMPS
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- WELDING SLEEVES
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FRANK WHEATLEY PUMP & VALVE MFR.

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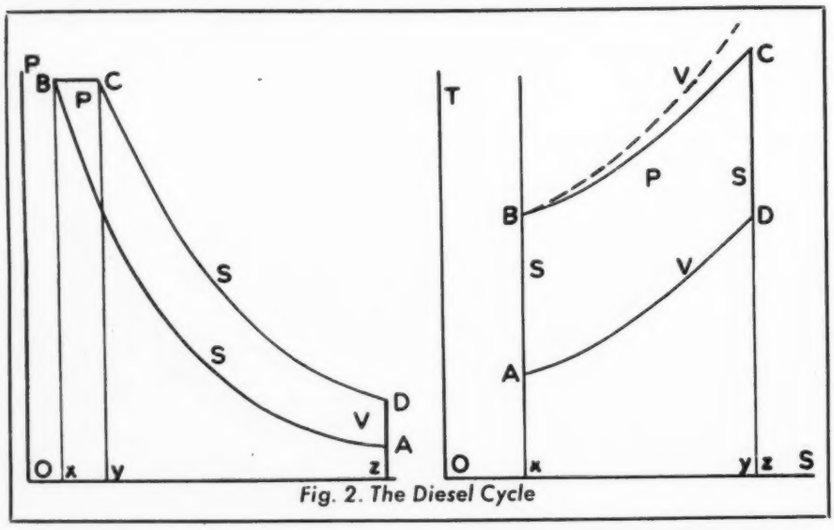


Fig. 2. The Diesel Cycle

$p_b = 14.5 \times 36.33 = 527$ lb. abs.

$$\frac{T_b}{T_a} = \left(\frac{V_a}{V_b}\right)^{n-1} = (14)^{0.361} = 2.593$$

$T_b = 560 \times 2.593 = 1452°F.$ abs.,
or $1452 - 460 = 992°F.$

It is interesting to compare this value of T_b with that of the Otto cycle, which has only a 5 to 1 compression ratio, and the compression ignition principle of the Diesel engine will thus be better understood.

Also, ${}_aS_b = 0$, as this is also an adiabatic compression.

To find the temperature and volume at point C, remember this is a constant pressure process B-C, with 100 B.t.u. being released in 0.2 lb. of gas having a C_p of 0.245.

$${}_bH_c = {}_wC_p(T_c - T_b),$$
$$100 = 0.2 \times 0.245(T_c - T_b)$$

Therefore:

$$(T_c - T_b) = \frac{100}{0.049} = 2040°F.$$

$T_c = 1452 + 2040 = 3492°F.$ abs.;
$V_c = V_b \times 3492 = 2.405$
but $V_a = 14V_b$
Therefore:
$V_b = 0.0714\ V_a$ and $V_c = 0.1718\ V_a$
Hence:

$V_a = \frac{14}{2.405} V_c = 5.825\ V_c$ or the expansion ratio of this cycle is 5.825, whereas its compression ratio is 14.

$${}_bS_c = 0.2 \times 0.245 \log_e \left(\frac{3492}{1452}\right)$$
$$= 0.049(0.8776) = 0.043 \text{ units.}$$

$$\frac{T_c}{T_d} = \left(\frac{V_d}{V_c}\right)^{n-1} = (5.825)^{0.361} = 1.89$$

Therefore:

$T_d = \frac{3492}{1.89} = 1848°F.$ abs. or $1388°F.$

$$\frac{p_c}{p_d} = \left(\frac{V_d}{V_c}\right)^{n} = (5.825)^{1.361} = 11.01$$

Therefore:

$p_d = \frac{527}{11.01} = 47.85$ lb. abs.,
or 34.15 lb. gauge.

These values may be checked by the usual formula in which

$$\frac{{}_oV_o}{T_o} = \frac{p_1V_1}{T_1},$$

and using the volume of 14, and 1 and 5.825 irrespective of the units. These volumes are relative, no units having been applied.

$${}_dS_a = 0.2 \times 0.18 \log_e \frac{560}{1848}$$
$$= 0.036(-1.1938) = -0.043 \text{ units.}$$

Find the heat rejected from D-A and solve by the basic definition of efficiency.

$$\text{Efficiency} = 1 - \frac{1}{n}\left(\frac{T_d - T_a}{T_c - T_b}\right)$$
$$= 1 - \frac{1}{1.361}\left(\frac{1848 - 560}{3492 - 1452}\right)$$
$$= 1 - \frac{1}{1.361}\left(\frac{1288}{2040}\right)$$
$$= 1 - 0.464 = 0.536 = 53.6 \text{ percent}$$

By definition:

Heat rejected $= 0.2 \times 0.18(1288) = 46.4$ B.t.u.

$$\text{Efficiency} = \frac{100 - 46.4}{100} = 53.6$$

percent.

These results check completely.

The Carnot Cycle

Referring to Fig. 3, as the Carnot cycle operates between the same temperature limits as the Otto cycle, we have:

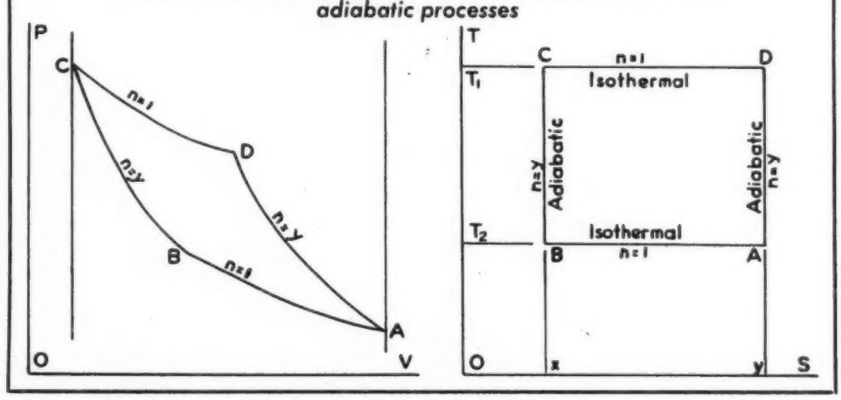
$T_a = 560°F.$ abs., $T_c = 3779°F.$ abs., and

$$\text{Efficiency} = 1 - \frac{T_a}{T_c} = 1 - \frac{560}{3779}$$
$$= 1 - 0.1481 = 85.19 \text{ percent.}$$

In actual practice, the pressures and temperatures would vary from the values obtained by solution. The specific heats of gases vary with the temperature to such an extent that the C_p for air increases from a value of 0.240 at 492°F. abs. to 0.255 at 2000°F. abs., and to 0.290 at 3500°F. abs. Under such conditions the 100 B.t.u. available would not have raised the temperature of the charge as high as indicated by the calculations. Also, there is an appreciable time required for complete combustion of the charge, and this process is not completed until several degrees after the piston has passed dead-center and expansion is underway. Again, there is at least a small percentage of blow-by passing the rings even in the case of a new engine. This is also the flow of heat from the charge of gas to the piston and cylinder as soon as the temperature of the gas is greater than that of the exposed metal. Then, the values of maximum temperatures and pressures are usually less than the values as calculated except for the pressure at C in the Diesel cycle. In actual practice, with an engine operating at full load, the pressure increase during the process B-C, that is, the firing pressure, is greater than the compression pressure. Also an influencing factor is the change in the number of molecules due to chemical reaction of the fuel. In some instances the number is increased and in some the number is decreased, but only by relatively small percentages. This is a subject, however, that would require considerable discussion and many calculations.

☆ ☆ ☆

Fig. 3. The Carnot Cycle consists of two isothermal and two adiabatic processes



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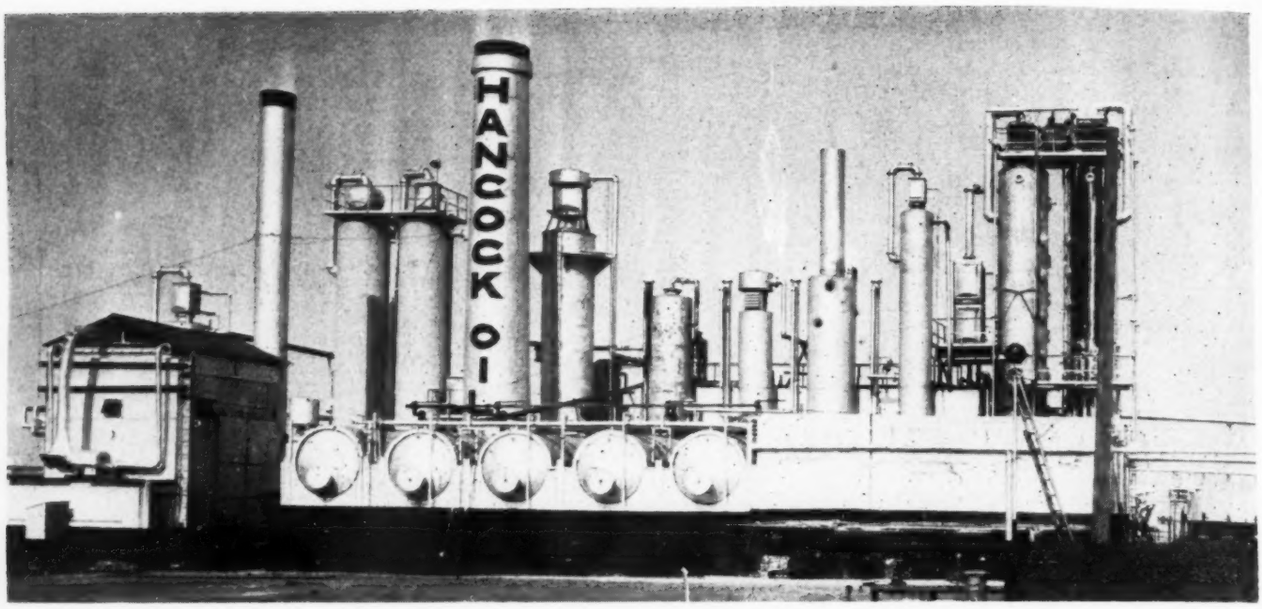


(Inman Co. Photo, Long Beach, California)

Some of the first steps. On the left, an early tube heater with flue gas recirculation. In the center, a battery of continuous shell stills. On the right, the old idea of pipe stills with tubes close to fires. Back of these can be seen fractionating towers with surface contact reflux sections, and one of the first dephlegmators

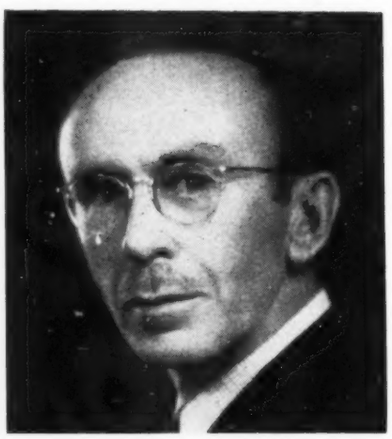
Tube Heater-Fractionating Tower Combination

☆ Its early development and its role in post-war processing methods

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

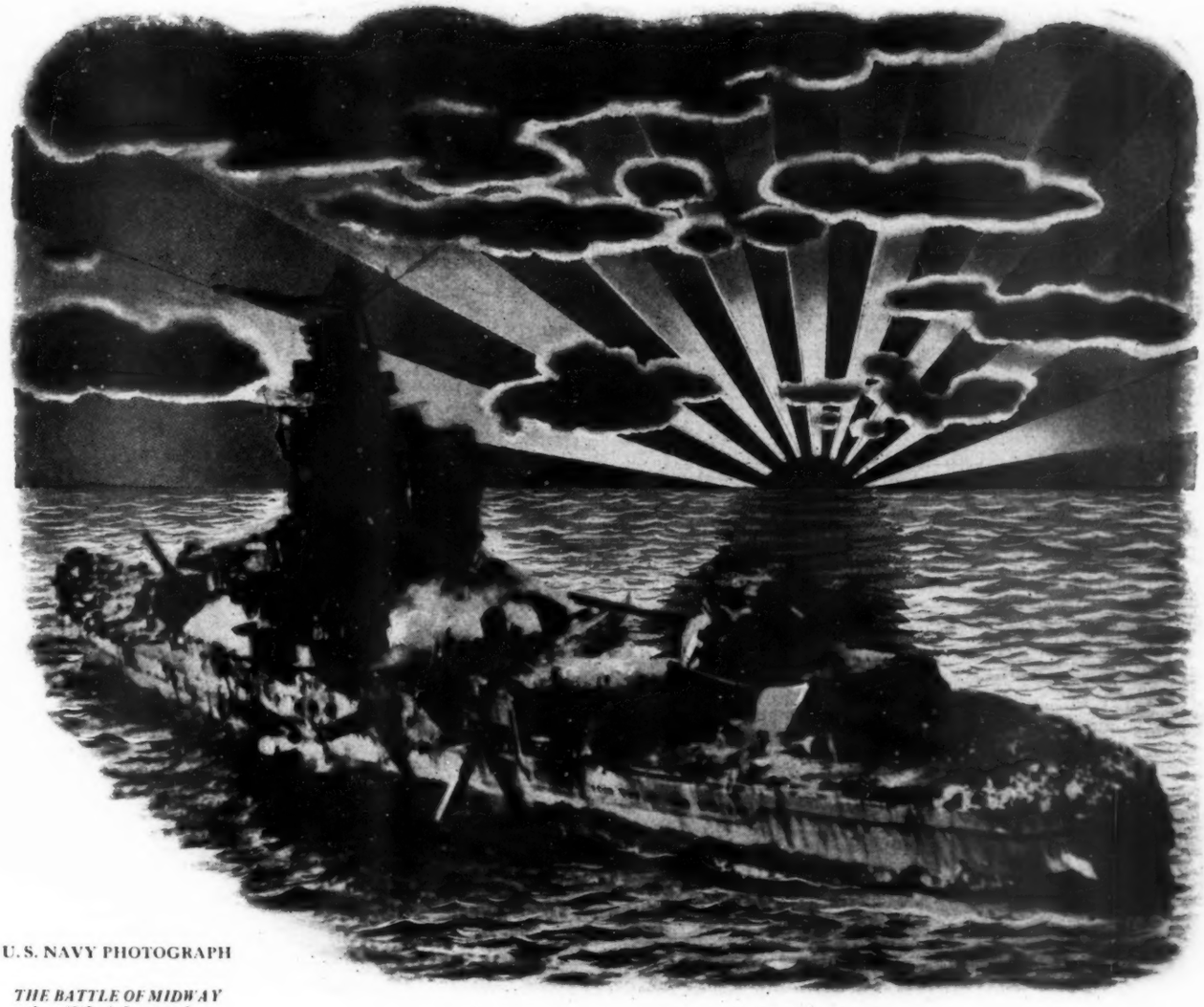
THE rationality of post-war planning in the fields of international geopolitics and economics is unquestionable and it is just as rational for a petroleum refiner to begin to plan the part he is going to play in the post-war period. As has been pointed out by the writer in previous articles in *The Petroleum Engineer*, much of the evidence pertinent to the petroleum case is already in, and it is interesting and potentially profitable to contemplate. Of one fundamental thing we may be entirely confident—the volume of petroleum products in demand is bound to be tremendously greater than it has ever been before. The number of products is certain to increase and the specifications will be more rigid. The processes whereby we shall meet both conditions are already rather clearly outlined.



R. G. LOVELL

The general principle of catalysis as the means of bringing about the molecular rearrangements that make these new and improved products available is well established. One step in the general process is destined to remain fundamentally the same. We must heat the oil before catalysis can become effective. The continuous tube heater has demonstrated its superiority for this duty, but in order to take full advantage of this superiority in the new processing, we are faced with the necessity of setting up an entirely different concept of tube heater duty than we have had heretofore. The continuous tube heater is efficient as a means of conveying heat to a body of oil, but it is not efficient when it is permitted or caused to extract heat from the furnace gases to bring the entire body of oil passing through it to a point required for the distillation of only a fraction of it.

The tube heater began to come into general use about 20 years ago. It was then referred to as a "pipe still." This



U. S. NAVY PHOTOGRAPH

THE BATTLE OF MIDWAY —June 1942. A Japanese heavy cruiser of the Mogami class after having been bombed by U. S. carrier-based naval aircraft.

On The Way Down

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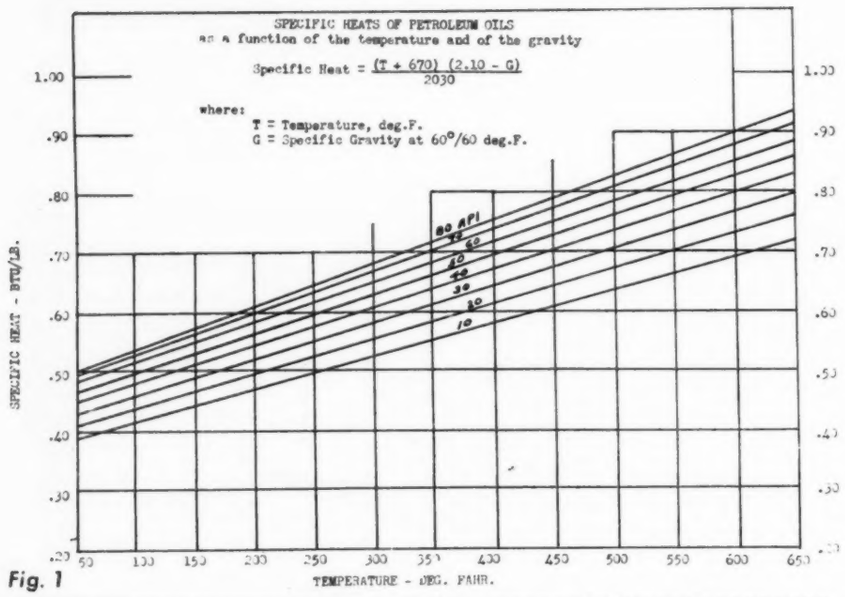

Fig. 1

misnomer gives a clue to the nature of a misapprehension that exists on the part of some. At that time straight-run distillation was the general thing. Cracking was still considered more or less an experiment. Continuous distillation using shell stills in battery had largely supplanted the batch method and the products were being cut to rather close boiling points, but the gasoline still required steam stilling to remove the effects of local overheating in the still. The latter trouble was alleviated by the use of bottom steam as an aid to circulation, but the slightest variation in either the quantity or the quality of this steam was sufficient to "puke" over the still and knock off the endpoint and color the gasoline by the slugs of heavy stock that came over with the vapors by entrainment. Dephlegmators of various designs were tried but they could not possibly remove the results of local overheating, which were a souring of the product

The development of the continuous pipe heater was, necessarily, tied to the development of the refluxing idea. Straight-run distillation called for a reflux ratio of about 3 to 1, but the heating efficiency of the continuous pipe coil over the shell still helped to overcome the enormous loss of heat in the refluxing operation, which loss, in itself, is one of the penalties to be charged against the tube heater. The error in the concept that the combination of tube heater and fractionating-by-refluxing made possible closer cuts than could be made by the battery of continuous shell stills, now comes to light. The tube heater-fractionator combination simply increased the throughput capacity per unit of time, equipment, and labor cost. Efficiency in the use of fuel was not given particular consideration because refinery gas and dry gas from the producing wells were plentiful and had little value. Now, however, we are learning something of the many, varied and profitable uses to which we can put these gases, and the proposition takes on a different aspect.

It is interesting to note how our ideas of furnace gases and fluid velocities have changed during the development of the tube heater. In the beginning, oil velocities were as low as 2 to 3 ft. per sec. This was probably based upon the thought that only by slow movement of the oil through the tube could it possibly absorb the required amount of heat. Standard iron pipe was generally used and seldom was greater than 3 in. I. D. It was also the generally held idea that the furnace gases must pass around the tubes at low velocity, else not enough of their heat could be transmitted to the oil. Further, as a result of early practice, the tubes were placed relatively close to the fires and the total free combustion area was altogether insufficient to attain anything like complete combustion before reaching the tubes without using several hundred percent excess air. All this frequently brought about a furnace efficiency as low as 25 percent, or, in other words, only 25 percent of the number of B.t.u. in the fuel appeared as heat in the oil. This compares with a figure of 85 percent now being attained. When it was realized that by providing a much more liberal firebox area complete combustion could be had with a marked increase in overall efficiency, a new trouble arose. Firebox temperatures were much higher as less excess air entered the furnace and the refractories did not hold up as before. Radiance had, in the meantime, come under consideration as a means of heat transfer to be considered separately from convection or conduction. It had also been found that, when the excess air had been reduced, the furnace gases were passing over the tubes at a considerably increased velocity even with no increase in stack height, and the increase in efficiency had been greater than could be accounted for by the better combustion conditions. Thus came a realization of the strong insulating value of the stagnant film of gas that surrounded and clung to each tube. Strangely enough, during this period, we had learned the value of turbulence in the oil on the inside of the tubes as a means of more effective heat transfer and of reducing local overheating, but had failed to conceive the same thing for the flow of heating gases.

Fuel Gas Recirculation

It seemed a natural thing to relieve the wall and roof refractories by placing additional heating coils on the sidewalls and under the roof. This was effective except in the rather restricted area over the bridge walls. These tubes persisted in burning out despite the higher oil velocity. The next development that came into favor and was widely and successfully used for several years was recirculation of fuel gases. This was a fairly simple matter of connecting the suction of a fan to the base of the stack and discharging these cooled and inert gases into the furnace rather close to the first tubes. This remedied much of the trouble from burned tubes, not altogether because of the higher induced velocity of the total furnace gases, but certainly, in a considerable degree, because of the diluent and cooling effect of the fuel gases. The point that had not been given proper recognition was that, although the film of stagnant gas was effective as an insulator against heat transfer by convection, it was not effective against radiant heat rays and the blast effect of the higher velocity of the furnace gases, when combined with the high temperatures, was the chief cause of the tube failures in the radiant section. Alloyed tubes have been an important factor, which will be considered later.

In passing it will be interesting to recognize in its true light one of the steps that, some 20 years ago, seemed to be the answer to burned tubes in the zone of radiant heat. It, further, may be helpful to define the limits of the zone of radiant heat. If one could get a strong flood-light picture of the inside of a furnace, everything that appeared in that picture would be within the zone of radiant heat. Clarity will be added to the mental picture if one will conceive that the incandescent walls of the firebox act as mirrors in reflecting the radiant rays upon tube areas not within their direct path. The

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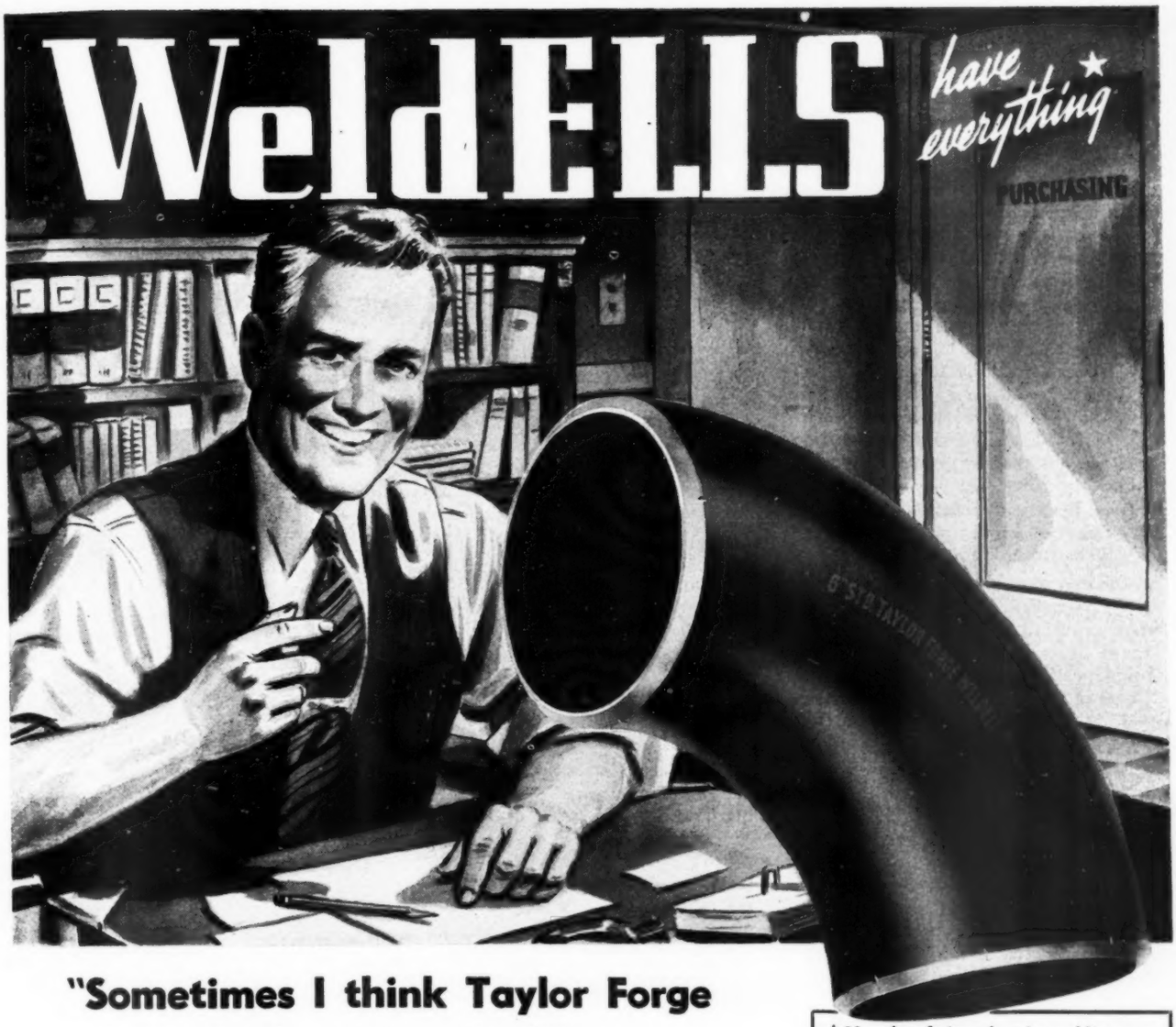

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IN this purchasing job a fellow is always in the middle with pressure groups on all sides. So you can sure breathe a sigh of relief when you come across a product like WeldELLS* that pleases them all down the line!

Take the men who give first importance to engineering considerations: They like the reinforcement of the inner wall and they like the tangents that keep the welds away from the zone of greatest stress.

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laws governing the absorption of heat from the sun's rays cover radiant heat as well. A surface that is bright in color reflects the rays and absorbs less heat than a surface that has a dull finish.

It had been found that it was possible so to impregnate the surfaces of steel shapes with powdered aluminum, and other bright metals, that the base metal resisted radiant heat to a point that prevented undue distortion, and made practicable the use of standard tee iron for support of tubes in furnaces. The process was also applied to the tubes themselves, but this, of course, tended to defeat the advantage of the radiant rays and some of the heat that might otherwise have been absorbed by the oil in these tubes simply passed on and was absorbed by convection in the following tubes but with lower efficiency. Better tube alloys and higher oil velocities solved the problem and one seldom has trouble from this source.

Modern practice provides area in the main or radiant chamber of the furnace so liberally that a condition of balanced draft exists at the top of the bridge wall and this changes to several inches of water draft in the convection section, because of its smaller area, thus sweeping away the film of stagnant gas around these tubes.

Wasted Heat Input

The heat required to vaporize the reflux is not wasted in the sense that it performs no useful work, but its exact equivalent must be put into the crude oil by the heater. In other words, the tube heater-fractionator combination requires that the entire body of crude oil be heated to a temperature high enough to distill off the heaviest fractions, which are recovered as distillate, and the heat used in the refluxing is that represented by the excess over the amount that would be used if each fraction were vaporized separately.

The heat taken from the crude oil to superheat the process steam should not be neglected. Normal steam enters the tower at a lower temperature, generally, than the incoming oil and, consequently, the heat added to the steam to equalize the temperatures must come from the oil. This is not a great amount, as the specific heat of steam is low, and will not, therefore, be calculated, but it definitely should not be forgotten. The heater is designed to heat oil and to take heat from the oil with which to superheat steam is not as efficient as to accomplish the same end by means of a steam superheating coil in the last passage in the convection chamber. The latter method usually utilizes heat that would otherwise be wasted to stack.

Calculations Are Simple

The writer has endeavored for years to bring home to the small refiner the wisdom of acquainting himself with the really simple methods of calculating fluid flow in pipes, heat exchangers, etc. Each individual knows his present needs and probable future requirements better than the heater manufacturer can possibly know them, no matter how thoroughly the latter may know the principles of combustion, heat exchange, and flow of fluids in pipe. On the other hand, the individual refiner cannot possibly be thoroughly informed in heater design and construction in the same degree as the manufacturer who has learned by experience and must constantly be on the lookout for improvements.

In line with this thought we shall present simply the methods whereby anyone can calculate the approximate duty required of a tube heater. Experience has shown that the most effective way of doing this is to set up a hypothetical refinery distillation project and proceed to calculate the heater for the job. The expert in these matters may find cause for complaint in this rather rudimentary method, but results will be accurate enough for practical use.

TABLE I

	Percent of crude	Bbl. per day	Gal. per hr.	Deg. A.P.I.	S. G.	Lb. per gal.	Lb. per hr.
VIRGIN CRUDE	100	10,000	17,500	26	0.9	7.5	131,250
Light gasoline	5	500	875	65	0.72	6.0	5,250
Sec. gasoline	20	2,000	3,500	58	0.75	6.2	21,700
Kerosine distillate	5	500	875	36	0.84	7.0	6,125
Gas oil	10	1,000	1,750	30	0.88	7.3	12,775
Bottoms	60	6,000	10,500	14	0.97	8.1	85,050
Differential account dropped decimals							350

Table 1 shows how the material balance by weight per unit of time works out. Merely to present these figures is not enough. The manner in which they are determined is most important. Some of the values are arbitrary but are representative of a regular operation.

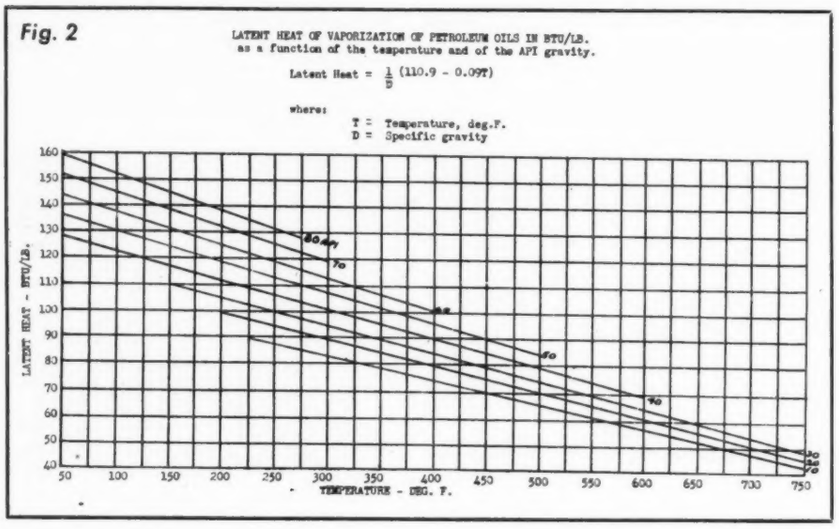
Conforming to good practice it will be assumed that 5 percent of the crude oil is recovered as a light gasoline by flashing, using heat exchanged from the tower bottoms. Percentages and specifications of overhead stocks are assumed, but the characteristics of the bottoms must be a result of calculations made from the arbitrary figures of the overheads. To find the lb. per gal. of the total overhead is a simple matter of weighted averages as follows:

$$\begin{aligned} 20 \text{ percent} \times 6.2 &= 124 \\ 5 \text{ percent} \times 7.0 &= 35 \\ 10 \text{ percent} \times 7.3 &= 73 \\ \hline 35 \qquad\qquad & \qquad 232 \end{aligned}$$

$$\frac{232}{35} = 6.63 \text{ lb. per gal. of total overhead}$$

Before some mathematician criticizes us for using the percentages of the various overheads in the virgin crude when only 95 percent of it is in the fractional distillation cycle, we point out that the result is the same as the percentages are relative to each other in any case. The calculations will involve only simple arithmetic, the conception that crude oil is a mixture of many hydrocarbons and compounds thereof, each of different boiling range, and a fairly keen imagination. The imagination is needed to perceive that, although fractional distillation requires that the entire body be heated to a temperature somewhat above the end boiling point of the heaviest fraction to be taken off, the heat necessary to heat and to vaporize each of the fractions differs in degree and amount, and the total heat to be put into the oil by the tube heater is equal to the sum of these duties.

Fig. 2



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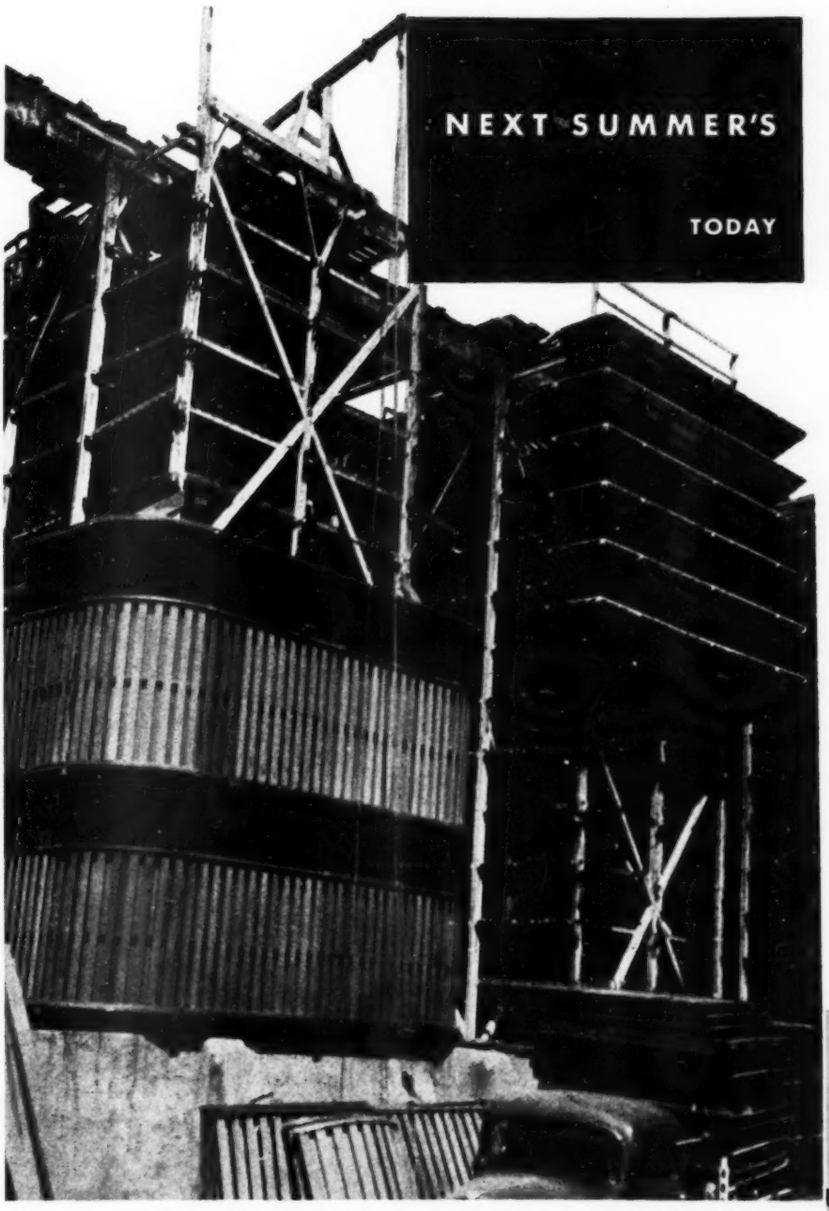

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Characteristics of Bottoms

The density (S.G.) of the bottoms is found by using the average of the total overheads and deducting it by percentage from the specific gravity of the crude charge.

$$\begin{array}{lr} 100\times 7.58 \text{ (lb. per gal. after flash)} & 758 \\ 35\times 6.63 & 232 \\ \hline 65 & 526 \end{array}$$

$$\frac{526}{65} = 8.1 \text{ lb. per gal.} = 0.9725 \text{ S. G.} = 14 \text{ A.P.I.}$$

Heat for Gasoline Recovery

In discussing the heat required to recover the gasoline fraction, first let us consider the amount of heat necessary to bring the gasoline fraction to the point of vaporization, which will be assumed to be 310°F.

A fair assumption of temperature of flash tower bottoms is 200°F. The specific heat, then, will be that necessary to raise the temperature of the weight per hour of gasoline in the crude oil from 200° to 310°F. A graph is submitted for that purpose (Fig. 1). Following up the vertical temperature line of 200°F. to intersection with the slanting line representing 58 A.P.I., and projecting this point to the left, we find that the specific heat is about 0.58. Do the same thing at 310°F. and find 0.65. The average of these is 0.62. Therefore, 21,700 × 0.62 × (310 — 200) = 1,479,940 B.t.u. per hr.

Latent Heat

The latent heat of vaporizing a pound of the gasoline will be found in the "Latent Heat" graph (Fig. 2) by noting the point of intersection of the 310° vertical temperature line with the 58° A.P.I. curve and reading 111 B.t.u. per lb. on the left ordinate. We will next begin to get an idea of the penalty to be paid in heat input for the convenience of fractional distillation. 21,700 × 111 = 2,408,700 B.t.u. /hr.

TABLE 2 — B.t.u. per hr.

	Gasoline	Kerosine distillate	Gas oil	Bottoms
Specific heat of liquid	0.65	0.60	0.60	0.58
Latent heat of vaporization	111.0	88.0	79.0	
Specific heat of vapors	0.55	0.56	0.57	
Range through which temperature is raised	200-310	200-410	200-450	200-550
To raise temperature of liquid	1,479,940	771,750	1,916,250	17,265,150
To vaporize	2,408,700	539,000	1,011,225	
To raise temperature of vapors	2,864,400	480,200	728,375	
	6,753,040	1,790,950	3,655,850	

Total heat demand: 6,753,040+1,790,950+3,655,850+ 17,265,150=29,464,990 B.t.u. per hr.

Specific Heat of Vapors

Although the gasoline fraction vaporizes at 310°F., it still absorbs its share of the heat needed to bring the full crude to a temperature of 550°F., which, with an adequate amount of steam, will be sufficient to vaporize the heaviest fraction, gas oil. This will be evidenced by the "Specific Heat of Petroleum Vapors" graph (Fig. 3).

The chart indicates that the average specific heat of the vapors of a 58-A.P.I. gasoline from 310 to 550°F. is 0.55. Therefore, the B.t.u. per hr. will be 21,700 × 0.55 × (550 — 310) = 2,864,400.

Total Heat

The calculations for the remainder of the overhead fractions are the same except for differences in quantities, temperatures, and specific heats. These are to be found in the graphs and in Table 1. Only specific heat is involved in the bottoms calculation.

From a study of Table 2 it will be seen that there is a substantial penalty to be paid in heat input to a body of crude oil passing through a tube heater for the convenience and relative simplicity of the tube heater and single fractioning tower system of straight-run distillation. It will be further interesting to carry the calculations on through the condensing and cooling of the overhead fractions and the cooling of the bottoms to a reasonable degree, and to find that the heat thus recovered, if the crude oil is used as the condensing and cooling medium, is sufficient to vaporize the gasoline fraction without furnace heat. The trend in tube heater design is more and more toward the idea of dividing up the heating job by furnace sections according to the demands of the processing cycle.

The input of fuel to the furnace will, obviously, be 29,464,990 divided by the percentage efficiency of the furnace. A figure of 75 percent will be close enough for a rough calculation. Approximate figures for fuel consumption can be found by giving a value of 6,300,000 B.t.u. per bbl. of fuel oil, or 1000 B.t.u. per cu. ft. of natural gas, and about 1800 B.t.u. per cu. ft. of cracking plant gas. An idea of furnace volume can be gained by the following:

$$\frac{\text{B.t.u. per hr. released from fuel}}{16{,}700} =$$

cu. ft. of combustion area required.

A fairly close estimate of oil velocity can be made by using:

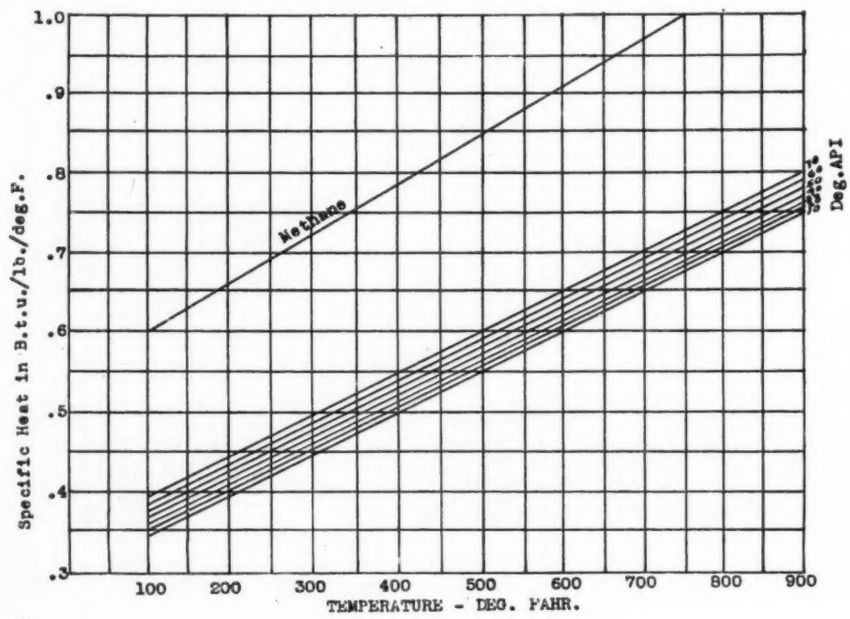
$$\text{Velocity in ft. per sec.} = \frac{\text{Bbl. per day} \times 0.009352}{\text{area of tube}} \text{ or,}$$

$$\text{Tube area} = \frac{\text{Bbl. per day} \times 0.009352}{\text{velocity}}$$

This formula is based on the reference temperature for oil, 60°F., and correction must be made for the increased volume at the average temperature of the oil passing through the heater.

No attempt should be made to use the formulas and other information in this article for any calculation wherein the oil is above its decomposition temperature. In cracking there are certain internal reactions that can be evaluated but not in so simple and easy a manner as with ordinary distillation. — ☆ ☆ ☆

Fig. 3 SPECIFIC HEAT OF PETROLEUM VAPOR



HANLON-WATERS Announces

an OUTSTANDING DEVELOPMENT

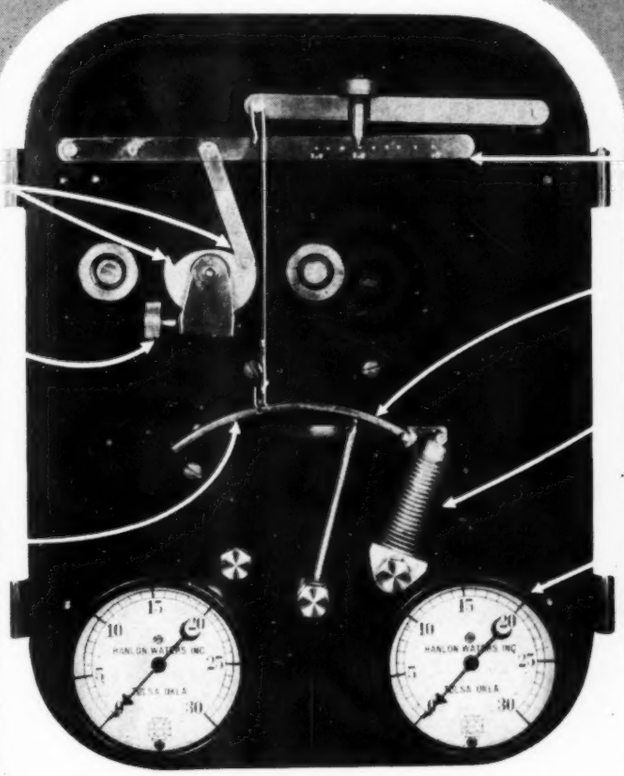
IN Level Control Pilots

for

- REFINING
- CHEMICAL
- SYNTHETIC
- GASOLINE
- RECYCLING

and

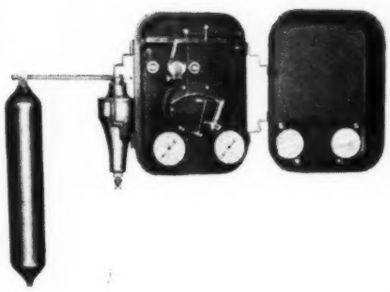
- POWER INDUSTRIES

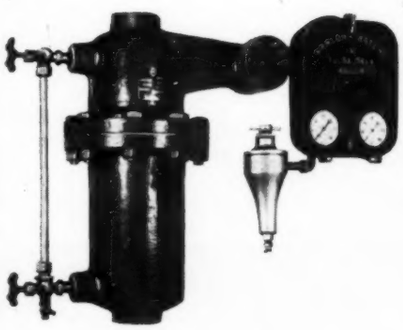


- Simplified-Reversibility
- Adjustment for height of Level Control.
- "Snap Action" settings on Pilot without use of any additional parts or special tools.
- Wide swinging door — easy accessibility of all parts.
- Mountable on any H-W Type 850 Displacement Level Control.
- Equipped with the popular H-W Type 245 Supply Medium Regulator.

- Specific gravity index scale setting from .10 to 2.0.
- WIDE THROTTLING RANGE adjustment from Zero to 300% —setting in exact relation to specific gravity setting.
- Long life bellows, operating throttle arm.
- Straight line pilot characteristic of pressure output to diaphragm vs. level variation.

no THE LEVEL CONTROLLER WITH STUFFING BOX . . . . . LEAKAGE . . . . . FRICTION





H-W New Type 1410 Level Control Pilot is especially designed to meet requirements for a Level Control Pilot having a VERY WIDE "Throttling Range"—EXACT in its relation to the specific gravity of the liquids handled in the system. Important for indicating or recording level service where the displacement float is used to indicate position of level in vessels where highly corrosive liquids make continuous use of gauge glasses impossible.

Features of the Type 1410 Level Control assure performance matching other H-W Control Equipment that are—

STANDARD FOR *Performance*

Hanlon-Waters, Inc.

TULSA, OKLAHOMA

Information on all HANLON-WATERS *Equipment is available at representative nearest you.*

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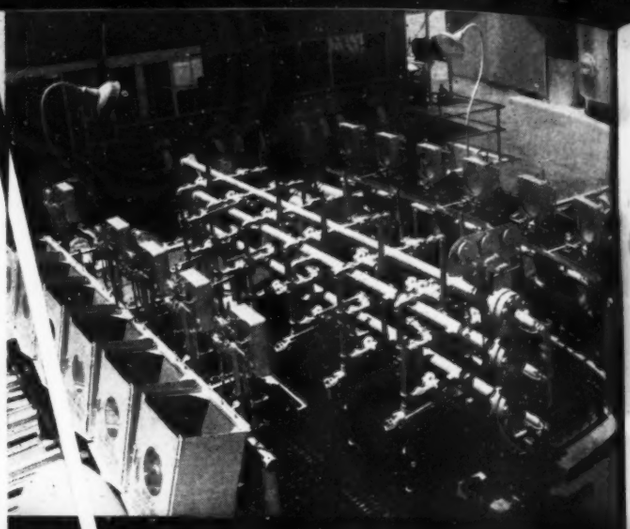
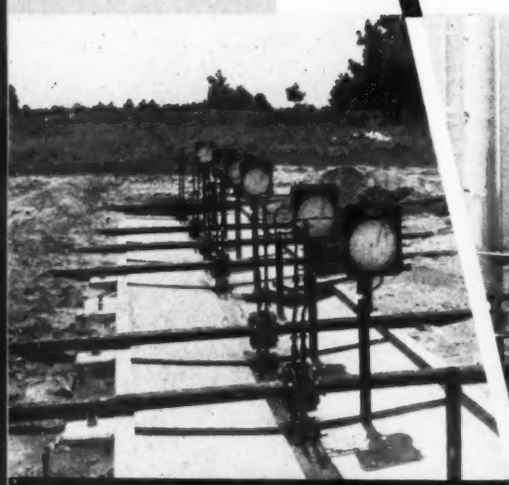
St. Louis • Kansas City • Denver • Los Angeles • Amarillo, Texas

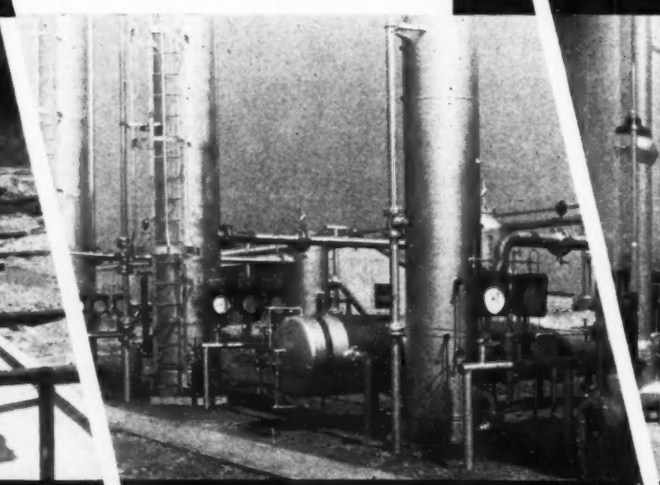
EMCO ORIFICE METERS



Manifold of EMCO meters, gas lift header service, in California

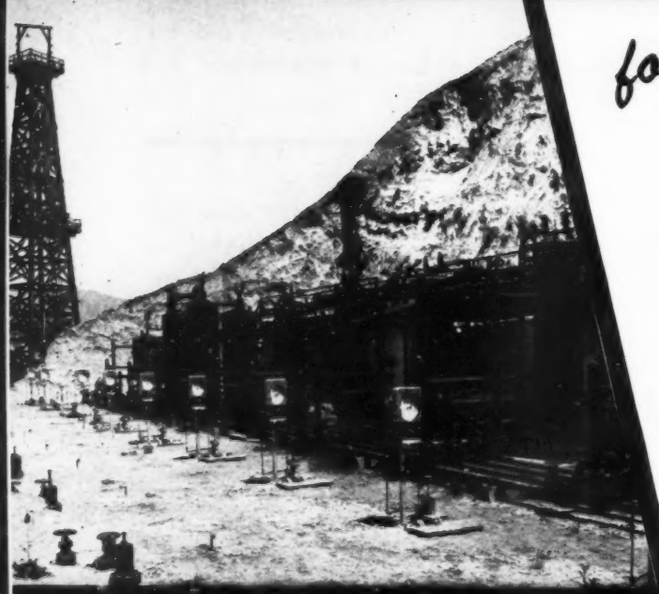


EMCO Orifice Meters at repressuring station in Texas



EMCO Orifice Meters on absorbers and stills in Southwest plant

New Mexico natural gasoline plant EMCO equipped



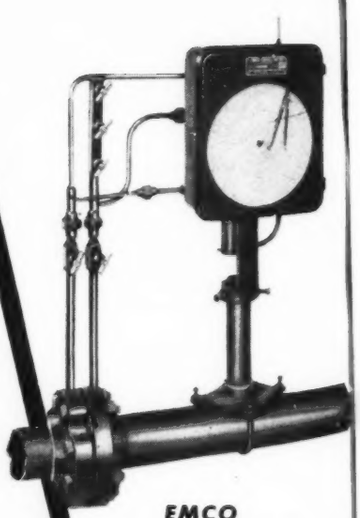
California "trap farm" equipped with EMCO Orifice Meters

for . . .

ACCURATE TROUBLE-FREE LARGE VOLUME MEASUREMENT

THE many features built into the EMCO Orifice Meter produce a meter that meets the approval of not only those responsible for measurement, but also those whose duty it is to keep measurement maintenance at a minimum and performance at a maximum.

The paramount consideration has been to provide a meter quickly accessible for adjustment and calibration, yet ruggedly constructed to assure a long life with a minimum of attention.



EMCO ORIFICE METER

INVEST TODAY IN BONDS FOR VICTORY

Meter Company

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 75

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously. More than 450 tables have been published.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions at the rate of $3.00 a year, or $4.00 for two years. General field classification numbers are as follows:

Nos. P000-P399—General

Nos. P400-P-499—Drilling

Nos. P500-P599—Production

Nos. P600-P699—Transportation and storage (includes pipe line)

Nos. P700-P799—Refining, including

Nos. P770-P799—Natural Gasoline, which may be classified in a separate division as shown here if of special interest to the user

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*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue, and 61-72, inclusive, in the June, 1943, issue.

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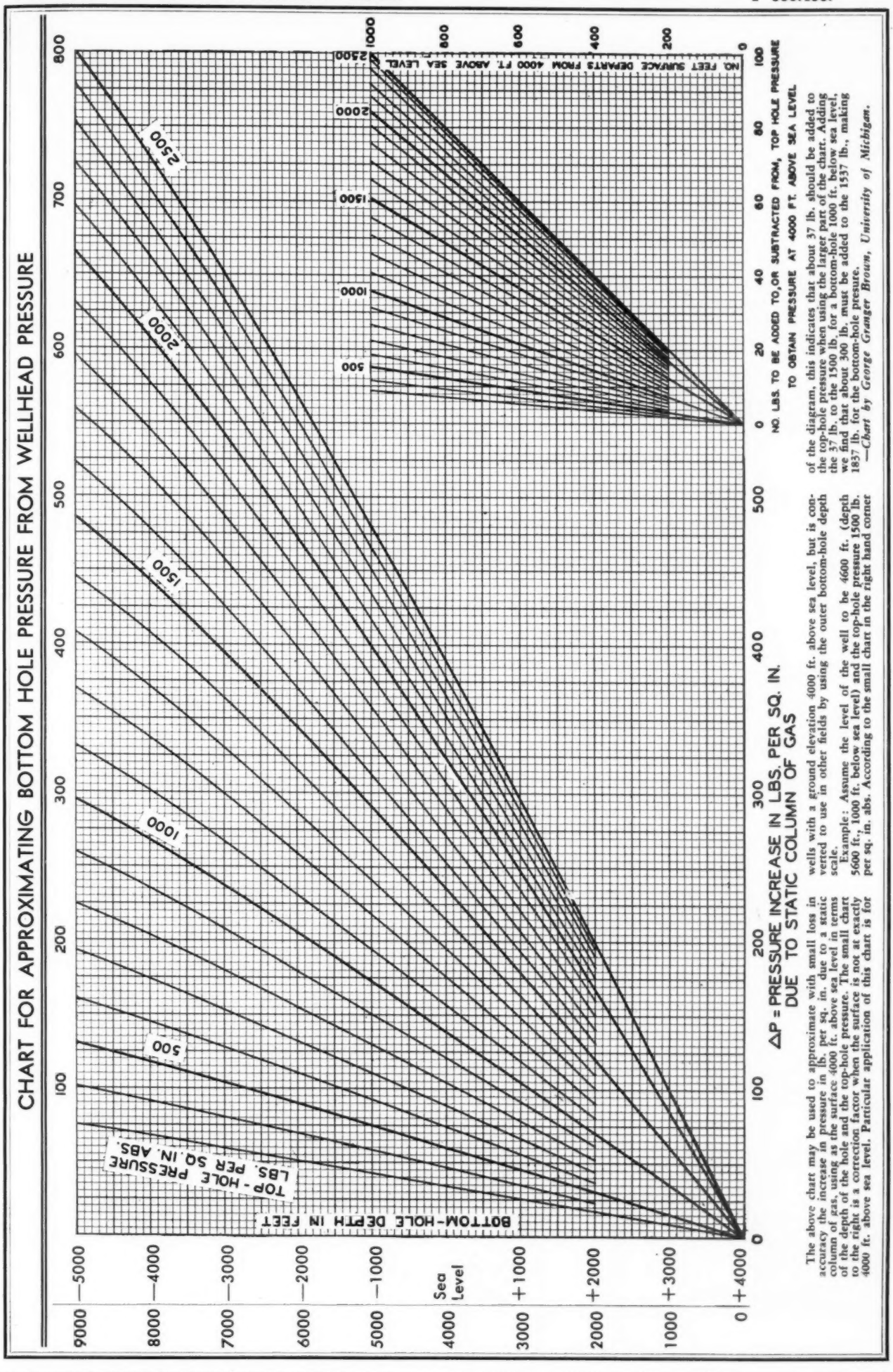


CHART FOR APPROXIMATING BOTTOM HOLE PRESSURE FROM WELLHEAD PRESSURE
TOP-HOLE PRESSURE LBS. PER SQ. IN. ABS.
BOTTOM-HOLE DEPTH IN FEET
ΔP = PRESSURE INCREASE IN LBS. PER SQ. IN. DUE TO STATIC COLUMN OF GAS
NO. FEET SURFACE DEPARTS FROM 4000 FT. ABOVE SEA LEVEL
NO. LBS. TO BE ADDED TO, OR SUBTRACTED FROM, TOP HOLE PRESSURE TO OBTAIN PRESSURE AT 4000 FT. ABOVE SEA LEVEL
2500
2000
1500
1000
500
Sea Level

The above chart may be used to approximate with small loss in accuracy the increase in pressure in lb. per sq. in. due to a static column of gas, using as the surface 4000 ft. above sea level in terms of the depth of the hole and the top-hole pressure. The small chart to the right is a correction factor when the surface is not at exactly 4000 ft. above sea level. Particular application of this chart is for wells with a ground elevation 4000 ft. above sea level, but is converted to use in other fields by using the outer bottom-hole depth scale.

Example: Assume the level of the well to be 4600 ft. (depth 5600 ft., 1000 ft. below sea level) and the top-hole pressure 1500 lb. per sq. in. abs. According to the small chart in the right hand corner of the diagram, this indicates that about 37 lb. should be added to the top-hole pressure when using the larger part of the chart. Adding the 37 lb. to the 1500 lb. for a bottom-hole 1000 ft. below sea level, we find that about 300 lb. must be added to the 1537 lb., making 1837 lb. for the bottom-hole pressure.

—*Chart by George Granger Brown, University of Michigan.*

Conserve steel by making every piece of equipment last longer. Steady production by keeping your machines in uninterrupted operation. Since the operation of your machines depends upon wire rope, make sure your operators keep these commandments:—

1. Inspect, clean and lubricate all wire rope regularly. Tighten fittings.
2. Be sure the rope is the proper one for the service. Ask your Hazard wire rope man.
3. If drums or sheaves are small, or the kinking tendency pronounced, specify LAY-SET Preformed, the rope that resists bending fatigue and kinking.
4. Check your sheave or drum grooves. Worn grooves play havoc with wire rope.
5. Don't let rope rub against any standing part.
6. If the rope deviates from the center plane of the sheave more than 1½ degrees, undue wear will result.
7. Keep sheaves aligned and bearings tight and properly lubricated.
8. Don't allow bad spooling on drums. Hazard LAY-SET Preformed spools evenly under most conditions.
9. Don't jam on power or brake. Jerky operation accelerates rope failure.
10. Don't let a load spin and twist the rope.

Get the experienced recommendations of a Hazard wire rope man. Specify Hazard LAY-SET Preformed for a rope that resists bending fatigue, kinking and snarling. Use LAY-SET because it spools better, is faster and safer to handle, lasts longer.

Keep equipment in good condition. Make it last longer.

HAZARD WIRE ROPE DIVISION

Wilkes-Barre, Pa., Chicago, Pittsburgh, Fort Worth, Houston, Wichita, San Francisco, Denver, Los Angeles

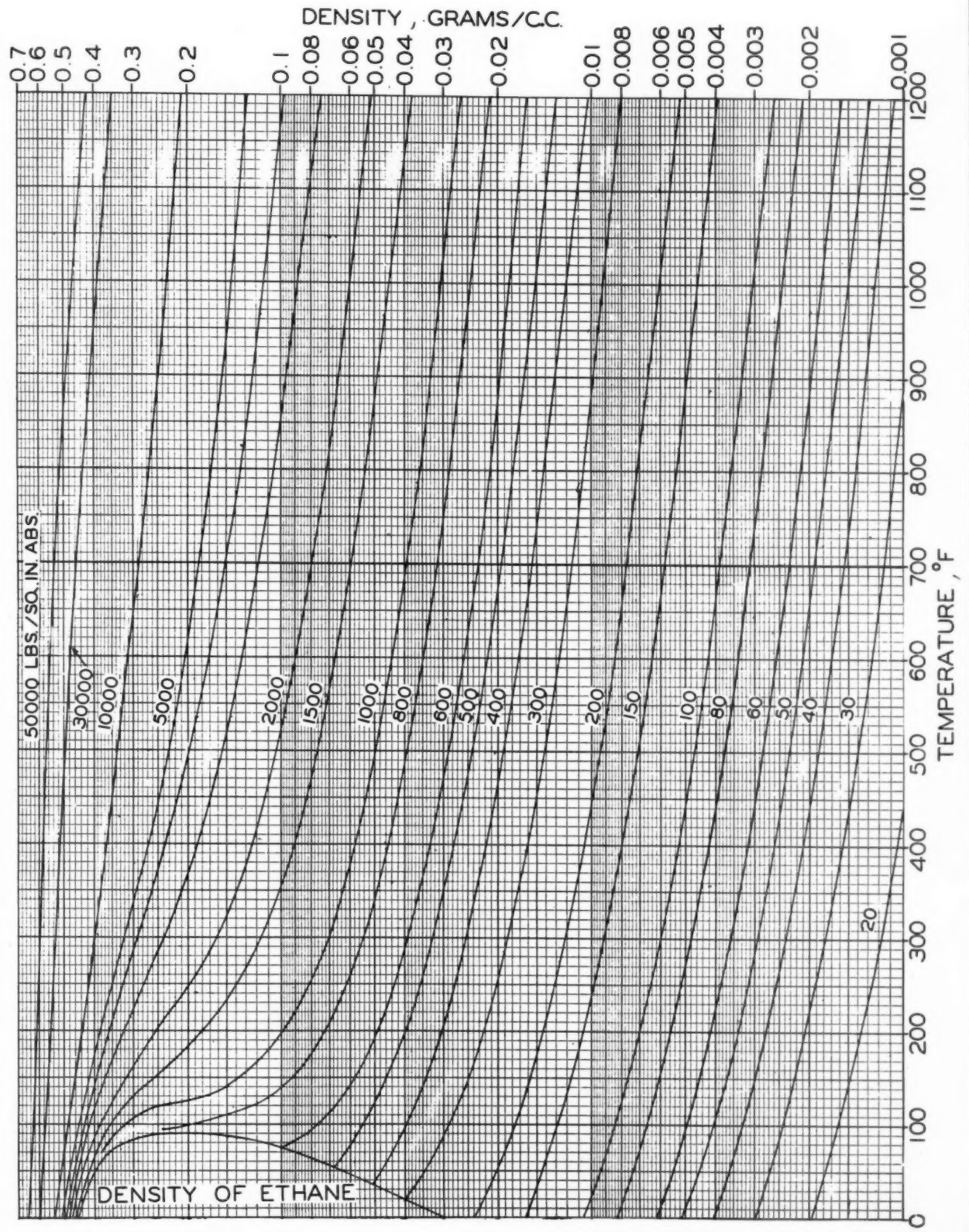
Distributors in all important oil field centers

AMERICAN CHAIN & CABLE COMPANY, INC.

BRIDGEPORT, CONNECTICUT

HAZARD LAY-SET Preformed ROTARY LINES

DENSITY OF ETHANE



—Chart by George Granger Brown, University of Michigan.

EXHAUST SPARK FIRE HAZARD ELIMINATED

Maxim Spark Arrestor Silencers not only provide effective silencing of exhaust noise but also trap 100% of the exhaust sparks and embers that can be a serious fire hazard in the handling of volatile liquids.

It is obvious that the elimination of engine exhaust roar makes for better working conditions and less noise strain on employees. No less obvious is the safety factor that Maxims provide in eliminating a serious fire hazard at a time when neither the industry nor the nation can afford any interruption in the production and delivery of petroleum products.

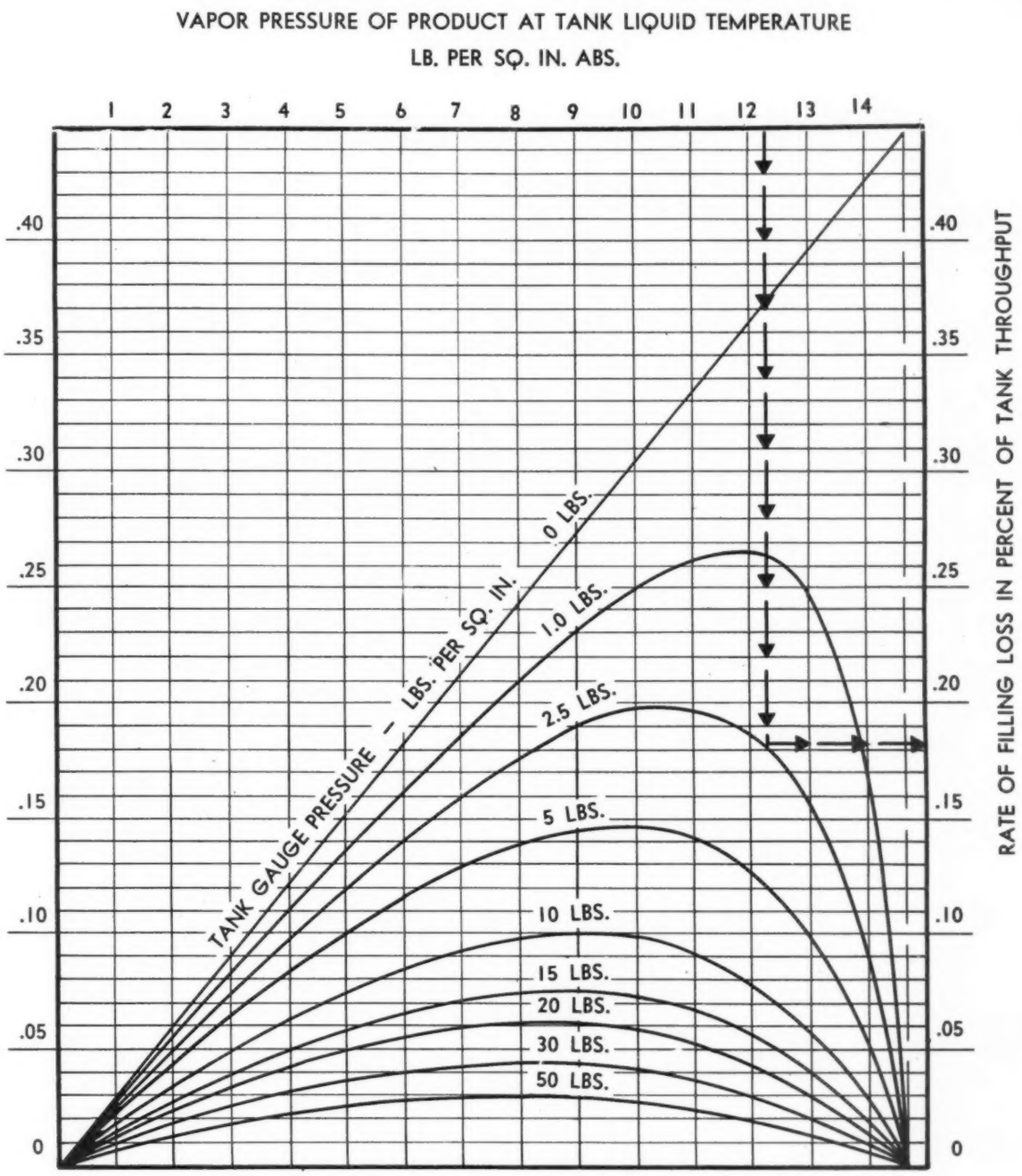
MAXIM WASTE HEAT UNITS SAVE FUEL...

by combining silencing with the conservation of waste exhaust heat to produce steam or hot water. Bulletins WH-100, WH-102 and WH-103 on request. The Maxim Silencer Co., 90 Homestead Ave., Hartford, Conn.

MAXIM

SILENCERS and SPARK ARRESTORS

THEORETICAL FILLING LOSS RATES FOR STORAGE TANKS AND PRESSURE VESSELS



The magnitude of the filling loss from an atmospheric storage tank may vary greatly depending upon the manner in which the tank is operated. If, for example, a tank, after standing full for some time could be emptied quickly and then refilled immediately before any appreciable amount of vaporization could occur at the liquid surface, the gas displaced through the roof vent would be almost pure air and the filling loss would be negligible. Most storage tanks, however, are emptied at a rate which allows the vapor space plenty of time to become saturated before refilling occurs. In this case a tank volume of saturated vapor is lost during each filling. In special cases where the velocity of the incoming liquid is so great as to cause turbulence and resultant vaporization, the loss during filling may greatly exceed the loss due to straight displacement of saturated vapor.

In estimating filling losses, most oil companies consider that the air-vapor mixture in the vapor space is in equilibrium with the liquid, and that a volume of air and vapor equal to the volume of the incoming liquid is displaced during each filling. The loss calculated on this basis and expressed in percent of tank throughput may be obtained from the uppermost curve.

Example: What loss occurs during one filling of an 80,000 bbl. tank assuming that the air-vapor mixture is in equilibrium with liquid having a vapor pressure of 5.2 lb. per sq. abs. at tank liquid temperature?

Entering the chart from the top at 5.2 lb., thence downward to the curve for zero gauge pressure, the corresponding rate of loss is 0.16 percent of the throughput.

Loss for one filling = 80,000 x 0.0016 = 128 bbl. = 5376 gal.

The amount of filling loss from a pressure vessel will depend to a certain extent upon the rate at which the product is pumped in. The curves in the chart are based on the assumption that the pumping rate is sufficiently low to allow vapor to be reabsorbed at the liquid surface as filling proceeds. If the pumping loss is very high, the percent of filling loss may be greater than the theoretical values obtained from the chart. The curves are also based on the assumption that the vessel is emptied and then refilled in one continuous operation, which may or may not be true under actual operating conditions. If withdrawals and subsequent refillings are made in small increments representing only a fraction of the vessel's total capacity, the filling loss will be zero. Consequently, the actual operating conditions must be considered and the values obtained from the chart must be adjusted accordingly to arrive at a reasonable estimate of the filling loss for a particular pressure vessel.

Arrows show only direction through chart.

—Chart by Chicago Bridge and Iron Company, 1942.

SAVES TIME
FOR THE PIPING DESIGNER

Revised and Enlarged Edition

Simple and Easy to Use

Simplified Method
for
CALCULATION OF PIPE WALL THICKNESS
for Various Pressures and Temperatures
based on
A.S.T.M. and A.P.I. Specifications
and the A.S.A. Code for Pressure Piping

BULLETIN 43-A
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Originated and Developed by Engineering Department
MIDWEST PIPING & SUPPLY CO., INC.
St. Louis 4, Mo., U.S.A.

This bulletin will enable you to determine quickly and easily the required pipe wall thicknesses for commercial pressure and temperature conditions. All you do is select a factor from a table, divide it into the working pressure and then refer the quotient to a chart. You have no substitution in formulae . . . no extensive calculations . . . no reference to codes or specifications.

This bulletin will gladly be sent to anyone interested who requests it upon a business letterhead. Simply mention Bulletin 43-A and address the main office at St. Louis, Missouri.

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PIPING FABRICATORS AND MANUFACTURERS OF PIPE WELDING FITTINGS

ELECTRICAL TERMS AND FORMULAE

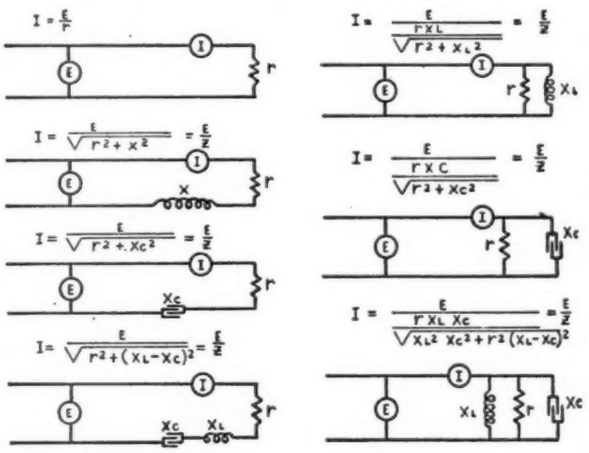
Formulae to determine Amperes, Hp., Kw., and Kv-a.

To Find	Direct Current	Alternating Current		
		Single Phase	2 Phase *—Four Wire	Three Phase
Amperes when Horsepower is known	$\frac{\text{Hp.} \times 746}{\text{E} \times \%\ \text{Eff.}}$	$\frac{\text{Hp.} \times 746}{\text{E} \times \%\ \text{Eff.} \times \text{P.F.}}$	$\frac{\text{Hp.} \times 746}{2 \times \text{E} \times \%\ \text{Eff.} \times \text{P.F.}}$	$\frac{\text{Hp.} \times 746}{1.73 \times \text{E} \times \%\ \text{Eff.} \times \text{P.F.}}$
Amperes when Kilowatts is known	$\frac{\text{Kw.} \times 1000}{\text{E}}$	$\frac{\text{Kw.} \times 1000}{\text{E} \times \text{P.F.}}$	$\frac{\text{Kw.} \times 1000}{2 \times \text{E} \times \text{P.F.}}$	$\frac{\text{Kw.} \times 1000}{1.73 \times \text{E} \times \text{P.F.}}$
Amperes when Kv-a. is known		$\frac{\text{Kv-a.} \times 1000}{\text{E}}$	$\frac{\text{Kv-a.} \times 1000}{2 \times \text{E}}$	$\frac{\text{Kv-a.} \times 1000}{1.73 \times \text{E}}$
Kilowatts	$\frac{\text{I} \times \text{E}}{1000}$	$\frac{\text{I} \times \text{E} \times \text{P.F.}}{1000}$	$\frac{\text{I} \times \text{E} \times 2 \times \text{P.F.}}{1000}$	$\frac{\text{I} \times \text{E} \times 1.73 \times \text{P.F.}}{1000}$
Kv-a.		$\frac{\text{I} \times \text{E}}{1000}$	$\frac{\text{I} \times \text{E} \times 2}{1000}$	$\frac{\text{I} \times \text{E} \times 1.73}{1000}$
Horsepower—(output)	$\frac{\text{I} \times \text{E} \times \%\ \text{Eff.}}{746}$	$\frac{\text{I} \times \text{E} \times \%\ \text{Eff.} \times \text{P.F.}}{746}$	$\frac{\text{I} \times \text{E} \times 2 \times \%\ \text{Eff.} \times \text{P.F.}}{746}$	$\frac{\text{I} \times \text{E} \times 1.73 \times \%\ \text{Eff.} \times \text{P.F.}}{746}$

I = Amperes; E = Volts; % Eff. = Percent Efficiency; P.F. = Power Factor; Kw. = Kilowatts; Kv-a. = Kilovolt-amperes; Hp. = Horsepower.

* For three-wire, two-phase circuits the current in the common conductor is 1.41 times that in either of the other two conductors.

Determining Current in Alternating Current Circuits



r = Resistance in Ohms

X_L = Inductive reactance in Ohms = $2\pi fL$

X_C = Condensive Reactance in Ohms = $\frac{1}{2\pi fC}$

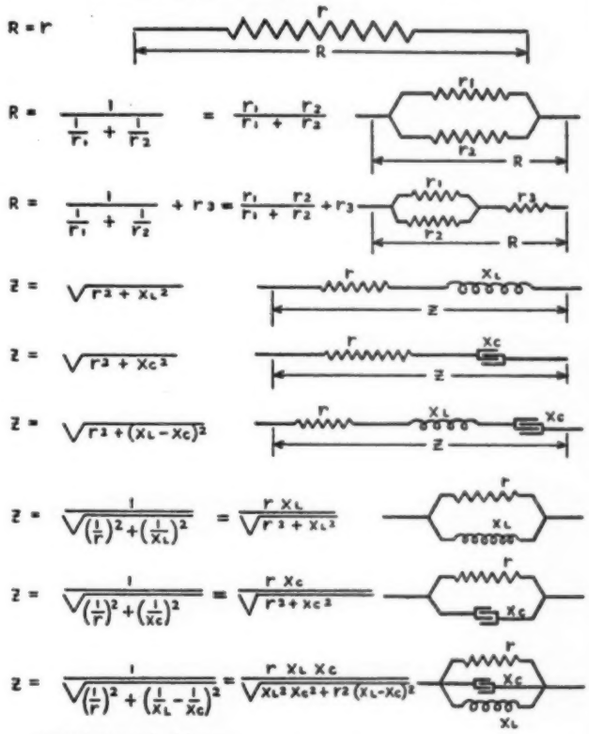
f = frequency; L = ind. in Henrys; c = capacity in Farads

Z = Impedance in Ohms

I = Current in Amperes

E = Pressure in Volts

Combining Resistance and Reactance



r = Resistance in Ohms

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f = frequency; L = ind. in Henrys; c = capacity in Farads

Z = Impedance in Ohms

I = Current in Amperes

E = Pressure in Volts

Electrical Terms and Definitions

Ampere—unit of current or rate of flow of electricity.

Volt—unit of electro-motive force.

Volt—unit of electro-motive force. Ohm—unit of resistance.

Ohm's law; current $= \frac{\text{Electro-motive force}}{\text{Resistance}}$

Volt Amperes—unit of apparent power. Megohm—1,000,000 Ohms.

Watt—unit of true power = volt amperes × power factor.

Watthour—unit of electrical work and is employed to indicate the expenditure of an electrical power of one watt for one hour.

Power factor—ratio of true to apparent power.

Torque (ft.-lb)—turning force represented by one lb. at radius one ft.

Horsepower—a measure of the time rate of doing work and is defined as the equivalent of raising 33,000 lb. one foot in one minute. One hp. = 746 watts.

Efficiency—the ratio of the useful "output" of a machine to its total "input."

Equivalent Values in Different Units

Kilowatt =
- 1,000 watts
- 1.34 hp.
- 2,655,000 ft.-lb. per hour
- 44,260 ft.-lb. per minute
- 737.3 ft.-lb. per second
- 3,142 heat-units per hour
- 56.9 heat-units per minute
- 0.948 heat-units per second
- 0.2275 lb. carbon oxidized per hour
- 3.53 lb. water evaporated per hour from and at 212°F.

Kilowatt-hour =
- 1,000 watthours
- 1.34 hp. hours
- 2,655,000 ft.-lb.
- 3,600,000 joules
- 3,412 heat units (B.t.u.)
- 367,000 kg.m.
- 0.235 lb. oxidized with perfect efficiency
- 3.53 lb. water evaporated from and at 212°F.

One Horsepower =
- 746 watts
- 0.746 kilowatts
- 33,000 ft.-lb. per minute
- 550 ft.-lb. per second
- 2,545 heat-units per hour
- 42.4 heat-units per minute
- 0.707 heat-units per second
- 0.175 lb. carbon oxidized per hour
- 2.64 lb. water evaporated per hour from and at 212°F.

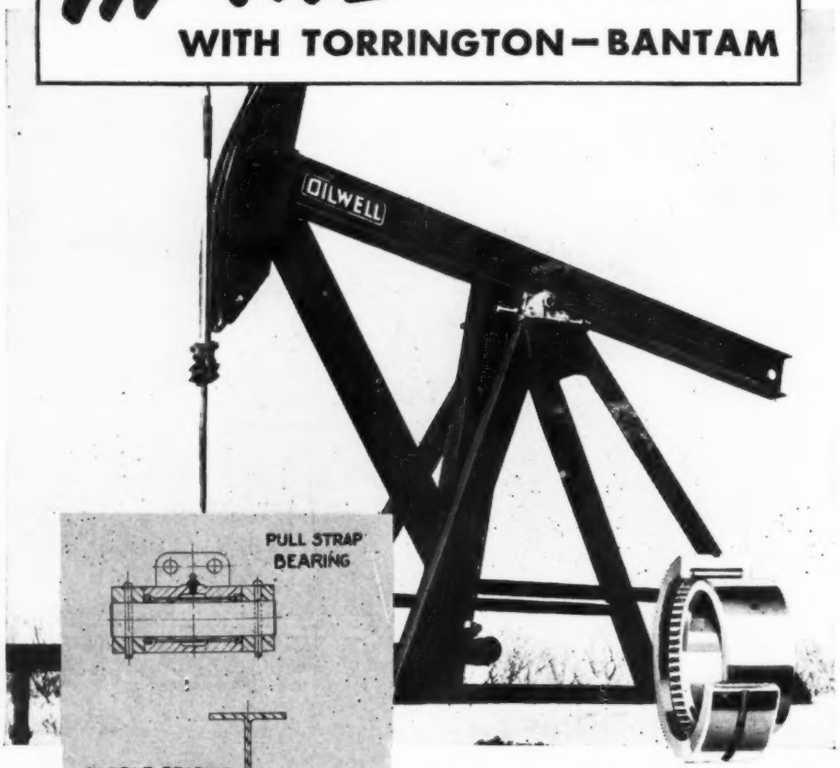
One Watt =
- 1 joule per second
- 0.00134 hp.
- 3412 heat-units per hour
- 0.7373 ft. lb. per second
- 0.0035 lb. water evaporated per hour
- 44.24 ft. lb. per minute

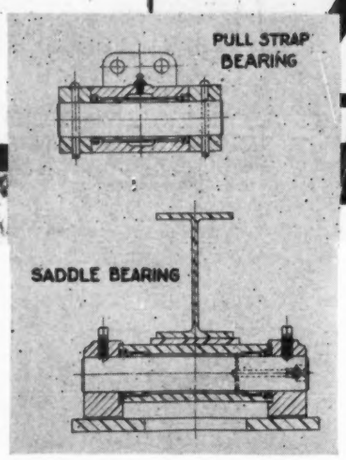
One Watt per sq. in. =
- 8.19 heat units per sq. ft. per min.
- 6371 ft. lb. per sq. ft. per min.
- 0.193 hp. per sq. ft.

One B.t.u. (British Thermal Unit) =
- 778 ft. lb.
- 17.452 watt minutes
- 0.293 watthour
- Latent heat of evaporation of water = 966 B.t.u.
- Latent heat of melting of water = 142 B.t.u.

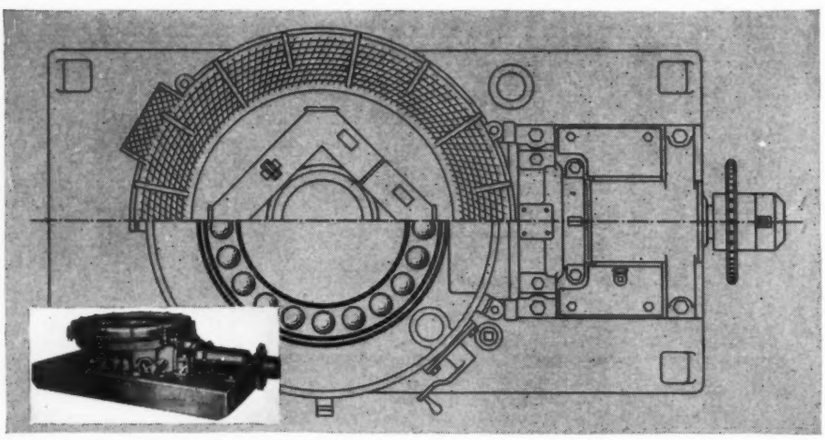
—From "Maintenance Hints," courtesy Westinghouse Electric and Manufacturing Company.

IN THE NEWS
WITH TORRINGTON—BANTAM



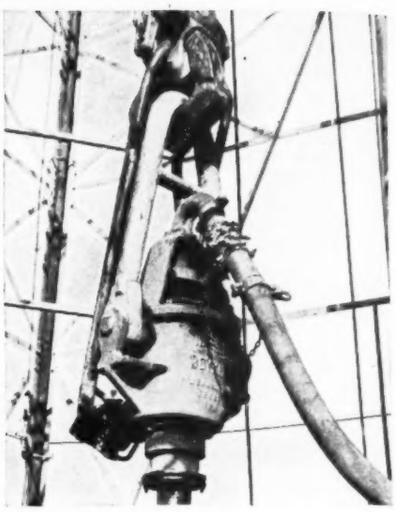


OPERATING EFFICIENCY, LOW UPKEEP are assured by the sturdy construction and advanced design of Oil Well Supply Company's pumping machinery. In the "Oilwell" No. 12-A Pumping Jack illustrated, Type NCS Needle Bearings contribute to reliable performance because of high load capacity, efficient lubrication and low friction coefficient. (Note pull-strap and saddle bearing use in x-section.)

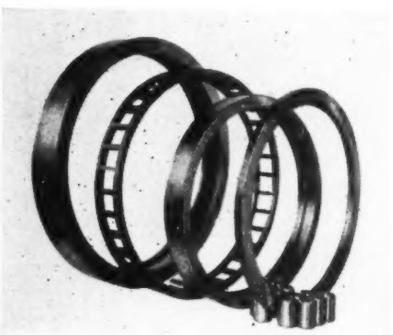


DRILL BITS are turning faster, boring deeper into the earth. This cutaway view shows one of The Wheland Company's High-speed Oil Bath Rotaries, designed to meet every requirement of present-day drilling practice—and large Precision Ball Bearings made by the Bantam Bearings Division are used to take both thrust and radial loads on the rotary table of this unit.

Bearings manufactured by Torrington-Bantam, such as Type NCS Needle Bearings, journal roller, straight roller, thrust and angular contact serve many other applications in the oil industry.



WELL DRILLING SPEEDS ARE FASTER, loads are heavier and depths are greater. 8-inch Oil-bath Rotary Swivels built by the International Derrick and Equipment Company embody in their design every feature and strength factor necessary in present-day drilling practice. Special types of bearings manufactured by Torrington's Bantam Bearings Division provide a safe load capacity far above the most rigid requirements of the service and are a vital factor in the high performance standards of this equipment.

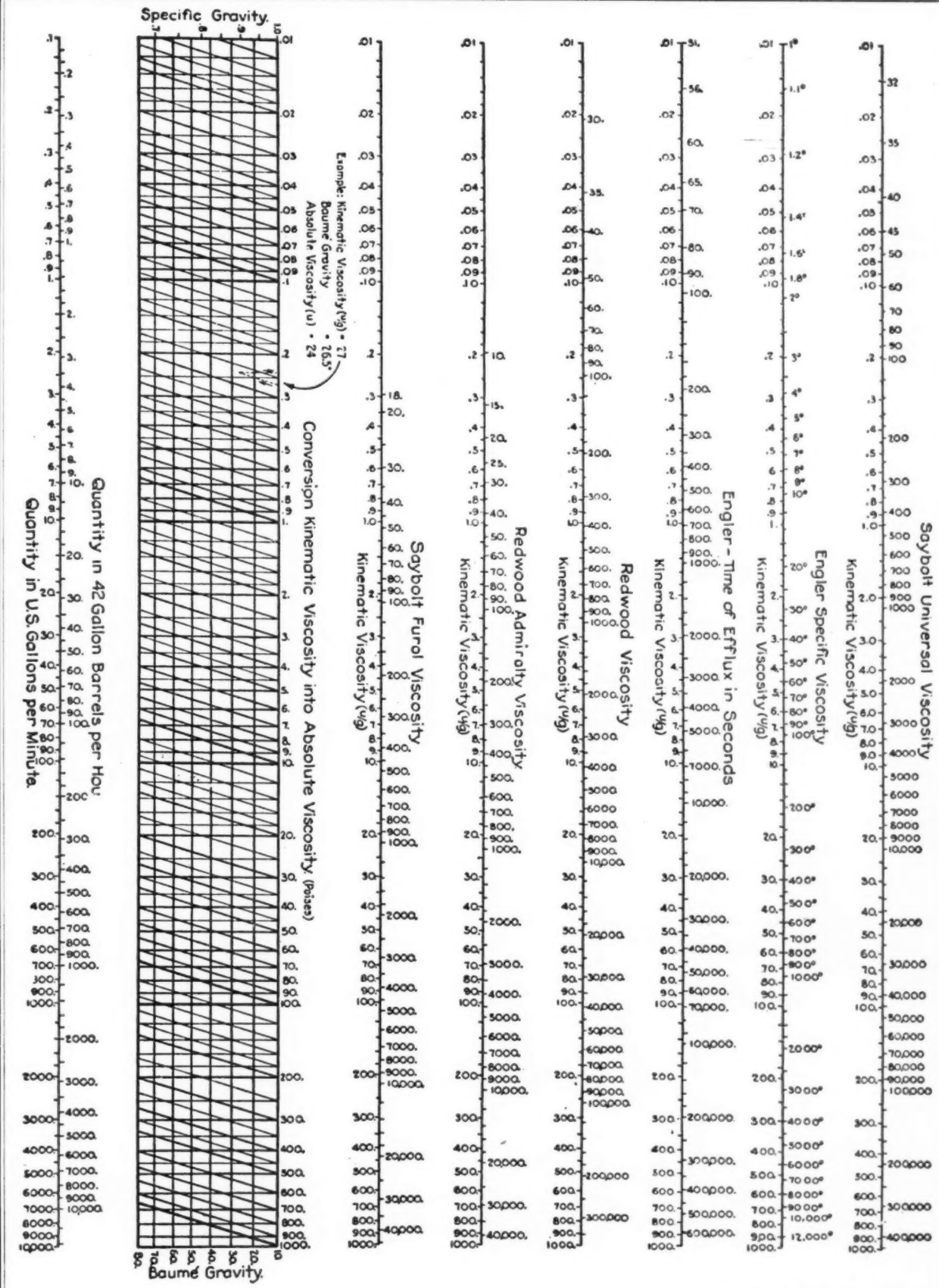


SIMPLER, MORE EFFICIENT DESIGN AND ASSEMBLY is often achieved by the use of special types of bearings such as these Journal Roller Bearings built for use in the crown and traveling blocks manufactured by the Emsco Derrick and Equipment Company. Measuring 27 1/2" O.D., they are provided with thrust shoulders built into outer races to eliminate hazardous thrust washers and contribute to compact design.

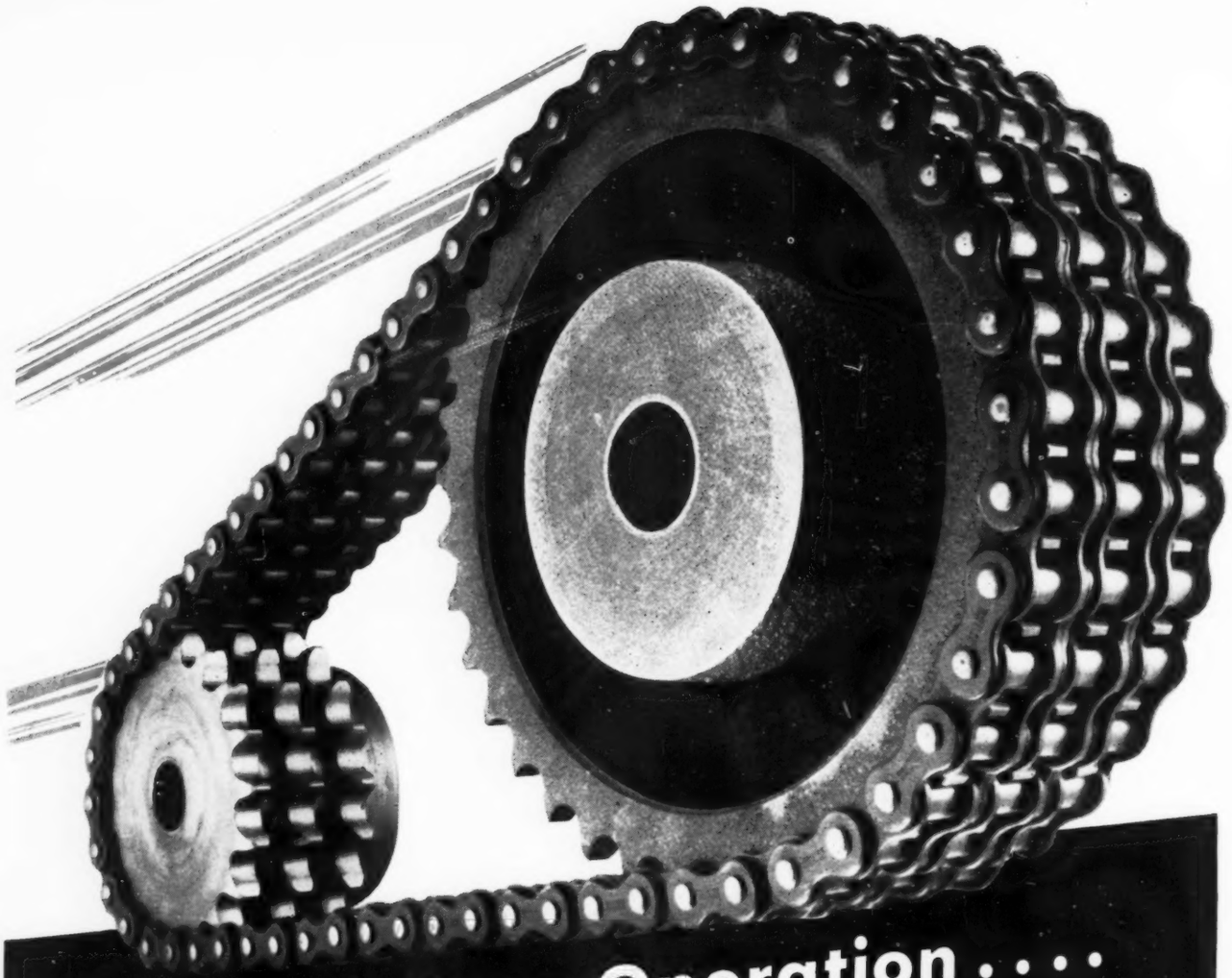
In addition to making every major type of anti-friction bearings—as well as a complete line of Needle Bearings—Torrington-Bantam often creates special types and custom-designed bearings for new and unusual applications. The oil industry is invited to TURN TO TORRINGTON for experienced engineering counsel in solving bearing problems.

ARMY NAVY
TORRINGTON BEARINGS
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL
THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

VISCOSITY CONVERSION CHART


Specific Gravity.
Example: Kinematic Viscosity(ν/g) • 27
Baumé Gravity • 26.5°
Absolute Viscosity(u) • 24
Quantity in U.S. Gallons per Minute.
Quantity in 42 Gallon Barrels per Hour
Conversion Kinematic Viscosity into Absolute Viscosity (Poises)
Kinematic Viscosity(ν/g)
Saybolt Furol Viscosity
Redwood Admiralty Viscosity
Redwood Viscosity
Engler - Time of Efflux in Seconds
Engler Specific Viscosity
Saybolt Universal Viscosity
Baumé Gravity.

—*From Standards of Hydraulic Institute.*



For Non-Stop Operation . . . .

drive with non-stopping

WHITNEY CHAINS

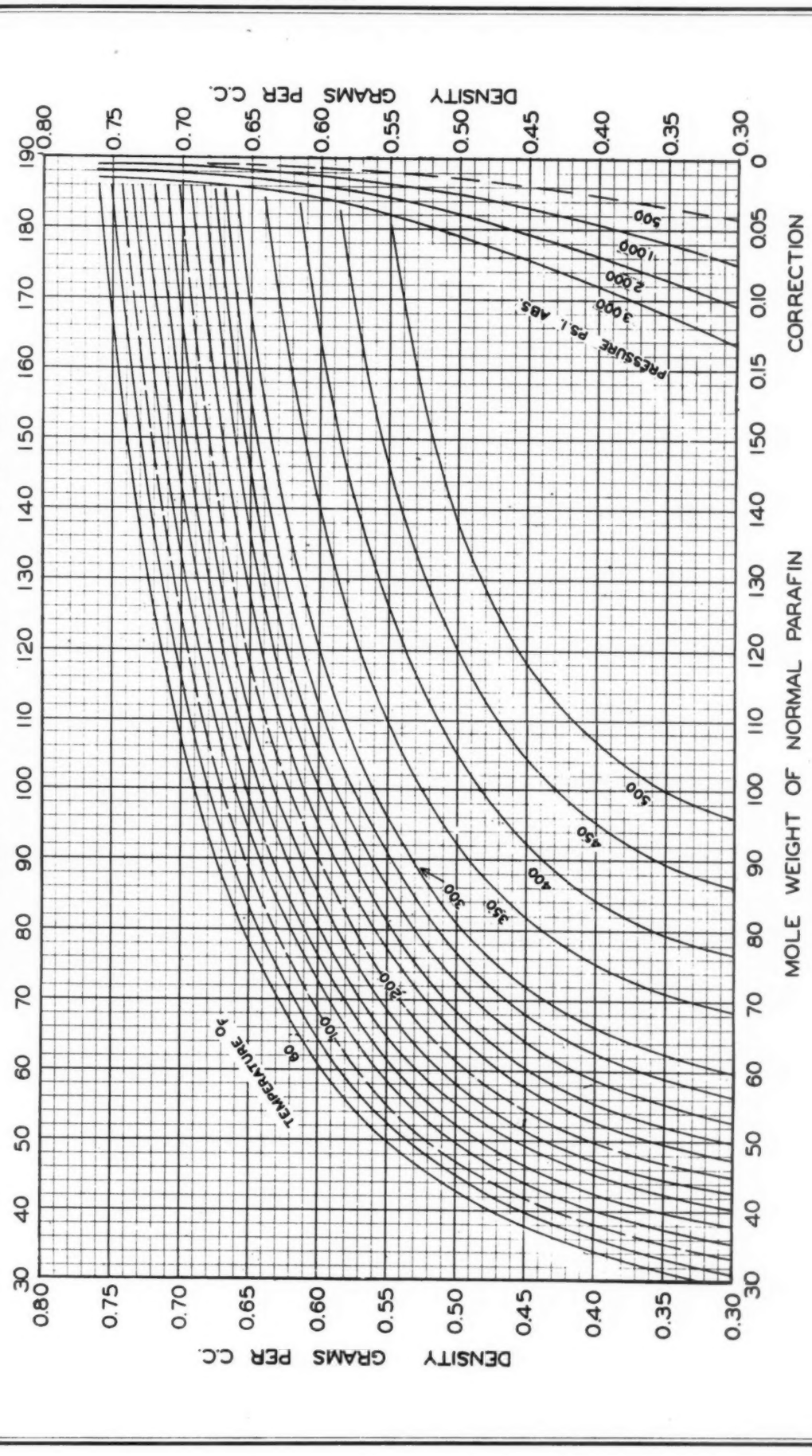
These are your *Duration Drives* for all oilfield or refinery equipment . . . smooth-rolling Whitney Roller Chains, fortified with the extra strength of Whitney alloy-armored steels. They keep delivering full power to the job 24 hours a day . . . even under shock and overload conditions . . . and with a minimum of maintenance requirement.

You can get Whitney Chains, plus the engineering co-operation you may need, if you will just pick up the nearest phone and "CALL CONTINENTAL".

The WHITNEY CHAIN & MFG. CO., Hartford 2, Conn.

WHITNEY CHAINS — **Distributed by: CONTINENTAL SUPPLY CO. DALLAS**

DENSITY OF LIQUID NORMAL PARAFFINS



The density of normal paraffins at atmospheric pressure is indicated on the ordinate for the molecular weight on the abscissa and the temperature on the curve.

The chart may be used to correct the density of all liquid hydrocarbons for changes in temperature and pressure if the molecular weight scale on the abscissa is not used to determine the density. When so used enter chart by density on ordinate and make temperature correction at the high pressure.

If the density at 60°F. is known (0.55 for example) and the density at some other temperature and pressure is required, (such as 100°F. and 2000 lb. per sq. in. abs.), enter chart from right at density (0.55) on ordinate and determine pressure correction for 2000 lb. per sq. in. from pressure curves at the right side of chart (0.028 on abscissa). Add this pressure correction (0.55 + 0.028 = 0.578) to obtain density at 60°F. and 2000 lb. per sq. in. Then determine density at 100°F. by entering chart from left at high pressure density (0.578) on the ordinate. From the intersection with the 60°F. curve, drop vertically to the desired temperature and read final density on ordinate (0.552 for this example).

If density is known at high temperature and pressure, follow the above procedure in reverse order. Enter chart from left at observed density (0.552 at 100°F. and 2000 lb. per sq. in.). Extend vertically from intersection of observed density and temperature (100°F.) to desired temperature and read density on ordinate (0.578 at 60°F. and 2000 lb. per sq. in.). Then correct density for pressure by subtracting correction from high pressure. It may be necessary to repeat the last step for the final value as the density on ordinate for pressure correction is the low pressure density.

—Chart by George Granger Brown, University of Michigan.

Here's BROWN FINTUBE'S latest development...

Using BROWN'S resistance-welded, integrally-bonded construction...They increase the heat transferring capacity of certain heat exchangers by a full 50%

● Brown Fintubes with their exclusive, resistance-welded integrally-bonded construction assure high thermal efficiency and trouble-free operation —And, of even greater importance, enables one lineal foot of Brown Fintube to provide the heat transfer capacity of from 4 to 10 lineal feet of plain bare tubing. Consequently, a fewer number, or shorter, Brown Fintubes are needed for a given heat transfer service than if plain bare tubes were used, resulting in *very substantial* saving in heat exchanger shell sizes—weights—pressure drops . . . and manufacturing, shipping, installation and maintenance costs.

Now, Brown Engineers have developed "cut and twisted" fintubes—secured by taking standard "longitudinal" fintubes,— cutting the fins transversely at desired intervals, and twisting the ends. These "cut and twisted" fintubes produce greater turbulency in the shell side commodity than straight untwisted fintubes, resulting in increased thermal efficiencies ranging up to 50% in Sectional Hairpin Exchangers, with *still further* savings in shell size, weight, shipping and manufacturing costs, etc.

Brown "longitudinal" and "cut and twisted" Fintubes are available in 6 standard—and many special types—of Brown Fintube Heat Exchangers —one or another of which will meet practically every requirement for effecting heat transfers between liquids and gases, or other commodities having unequal transfer co-efficients . . . Also in exchangers built by a considerable number of other concerns who regularly employ Brown Fintubes as the heat transfer medium in their exchangers. Let us quote on your requirements.

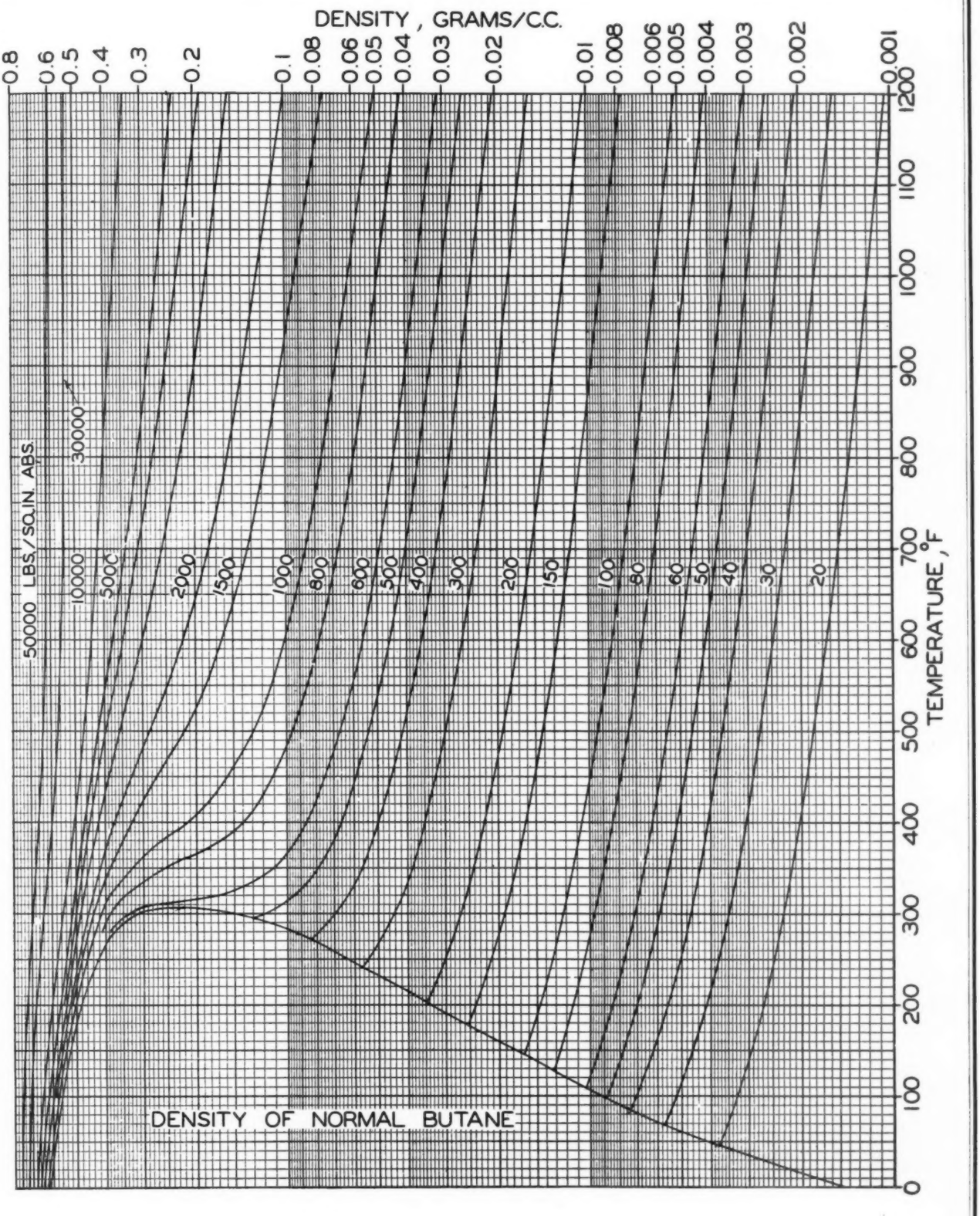
Brown Integrally Bonded Fintubes are used in all Brown Fintube Heat Exchangers—in exchangers made by most other manufacturers—and are available in a wide variety of sizes, and in mild carbon or special steels, for practically any heating or cooling requirement.

THE BROWN FINTUBE CO.

125 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

DENSITY OF NORMAL BUTANE



—Chart by George Granger Brown, University of Michigan.

This is THE BIG INCH of Pipelines—
Greatest Capacity **of any pipeline ever built**

—and this is the "BIG INCH"

OF ROLLER BEARINGS

These "Inch Series" Hyatts...like their famous pipeline namesake...have tremendous capacity... measured in tons and hundreds of tons.

And...as a further advantage...they are made in fractional size bores, for shafts from 4" diameter upwards.

Originally designed for the massive, heavily loaded, relatively slow moving oil well machinery, the use of this type of Hyatt Bearings (70,000 series) quickly spread.

Today they are serving and saving in mining equipment, industrial locomotives, power presses, pillow blocks, cranes and steel mill cars...as well as in numerous types of fighting equipment.

Keeping pace with the demands of industrial designers for the latest and best in anti-friction bearings has been Hyatt's job for fifty-one years.

The "Big Inch" is just one of the several types of Hyatt Bearings now being made. Each of them is designed for specific needs and purposes.

Call on our engineers for information about their profitable application to your products.

HYATT BEARINGS

Division of GENERAL MOTORS

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

Direct-Current Rigs for Deep-Drilling Operations

PART 2 (Continued)

by R. A. J. Dawson
Office of Petroleum Administration for War

Generator Controls

All generators and exciters rotate constantly at 1200 r.p.m., or another rated speed. The generators (and hence the motors they pair with) are controlled by use of a type of Ward-Leonard oil-immersed generator field control. This common control method has been used for many years for mine hoists, elevators, cranes, etc.

This control consists essentially in using the voltage of a small 25-kw. exciter generator to vary the field current in the larger generator. A large electric rig should have at least two exciter generators of 25 or more kw., these small machines turning at 1200 r.p.m. with the remainder of the rotating generative equipment, and *constantly* putting out 125 volts. These small exciters have a permanently charged field magnet construction, and by means of adjustable throttle resistances these small generators are used to control the large generators and hence the large motors.

The armatures of the large generators and the large driving motors are simply a closed circuit of heavy copper cables, and the driller controls each individual driving motor by means of the small wire circuit of the generator field. These driving motors can be reversed simply by reversing the field current of the generators, which changes the polarity and flow of the armature current.

By varying the field current of the generators from 0 to not more than 12 amp., it is possible with some setups to vary the driving currents from 0 to 2000 amp. The investment of this degree of power control in the small wire circuits is very efficient, and the speed and torque of the driving units can be easily varied at will. A simple circuit diagram of this method of control is shown in Fig. 7.

Starting and reversing features are usually imparted by one of two methods:

1. Location of starting and reversing mechanism within the driller's floor control rheostat.
2. Location of the above mechanism in the power plant exciter control cabinets.

Both methods are practicable, Manufacturer "B" being an illustration of the first in which 18 leads per unit are used to build up both a forward and reverse tapped rheostatic element within the driller's throttle drum controller. Manufacturer "C" averages eight control leads per unit in following the same general design. By using remote forward and reverse contactors the number of leads may be reduced to six per generator control as shown by Manufacturer "A." (Fig. 8.)

Most generator field circuits use some type of contactor coil to energize the circuit and such systems should include either a breaker or overload relay to prevent harm to generator field coils in case of sudden current overloads or shorts. In some instances these contactor coils together with the throttle controls complete the circuit and in such designs the contactor coils do double duty as "pickup coils."

Manufacturer "A" uses a main contactor coil, and in addition to this coil and his throttle rheostat, has either the forward or reverse contactor complete the field circuit. As the operation of the forward and reverse contactors is synchronized they serve as very efficient "pickups." (Fig. 9.)

Such "pickup" coils are needed to compel the driller to zero his throttle first and increase the field slowly in case of interruption of any of the interlocks or safety devices, or by breakdowns. If such coils or their equivalent were not used serious damage could result if the circuit interruption were to be resumed with the throttle partly open.

Manufacturer "A" uses the main contaetor outside the rotation changing phase of the circuit, and with this coil energizes only part of the field circuit. With both the forward and reverse contactors open, this type coil will close when the exciters are up to about 75 percent of rated voltage, and remains shut while the forward and reverse directional contactors control field action. This type of circuit is very flexible, has little wiring to the derrick floor, and is very easy to maintain.

Division of Drilling Operations

The various operations to be performed around any drilling rig can be divided into the following classes:

1. Hoisting and rotating.
2. Running hole pump.
3. Driving accessories.
   (a) Running mud stirring pump.
   (a) Running high-pressure water pump.

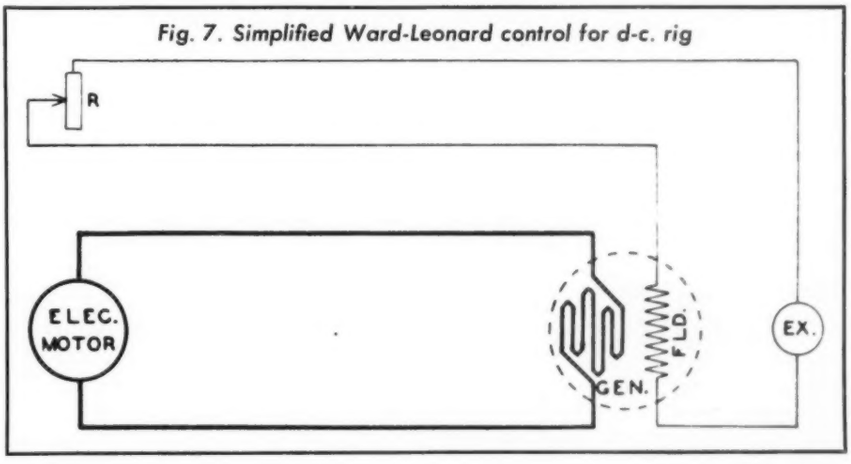
The best way to distribute this work with three generators is as follows:

Generator and Motor No. 1 does (a) hoisting and rotating.

Generator and Motor No. 2 does (b) driving hole pump.

Generator and Motor No. 3 does (c) driving accessories (in parallel).

Fig. 7. Simplified Ward-Leonard control for d-c. rig



If four generators and four driving motors are to be used the optimum distribution of assignments is as follows:

Generator and Motor No. 1 does (a) hoisting.

Generator and Motor No. 2 does (b) driving hole pump.

Generator and Motor No. 3 does (c) driving accessories (in parallel).

Generator and Motor No. 4 does (d) driving rotary.

When four generators and four motors are to be used, the rotary should be given a separate drive for the same reasons that this practice is so advantageous on a steam rig. If the rotary driving motor is of sufficient size, it can serve as an auxiliary unit in case of failure of the electrical circuit driving the drawworks.

Transfer Switches

Rather than have a generator able to supply only one of the driving motors with power, it is much better to have the armature circuits correlated so that in case of generator failure, the motor affected could be driven by one of the other generators.

Several types of transfer switches have been used for this purpose, and the types illustrated are two examples of simple double switch arrangements that provide armature circuit flexibility when so needed. (Figs. 10 and 11.)

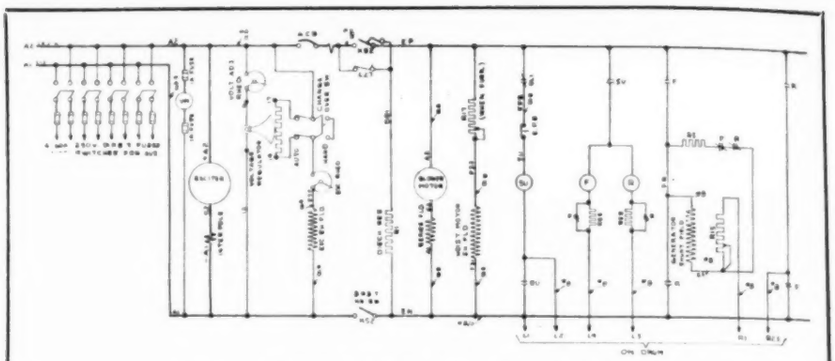


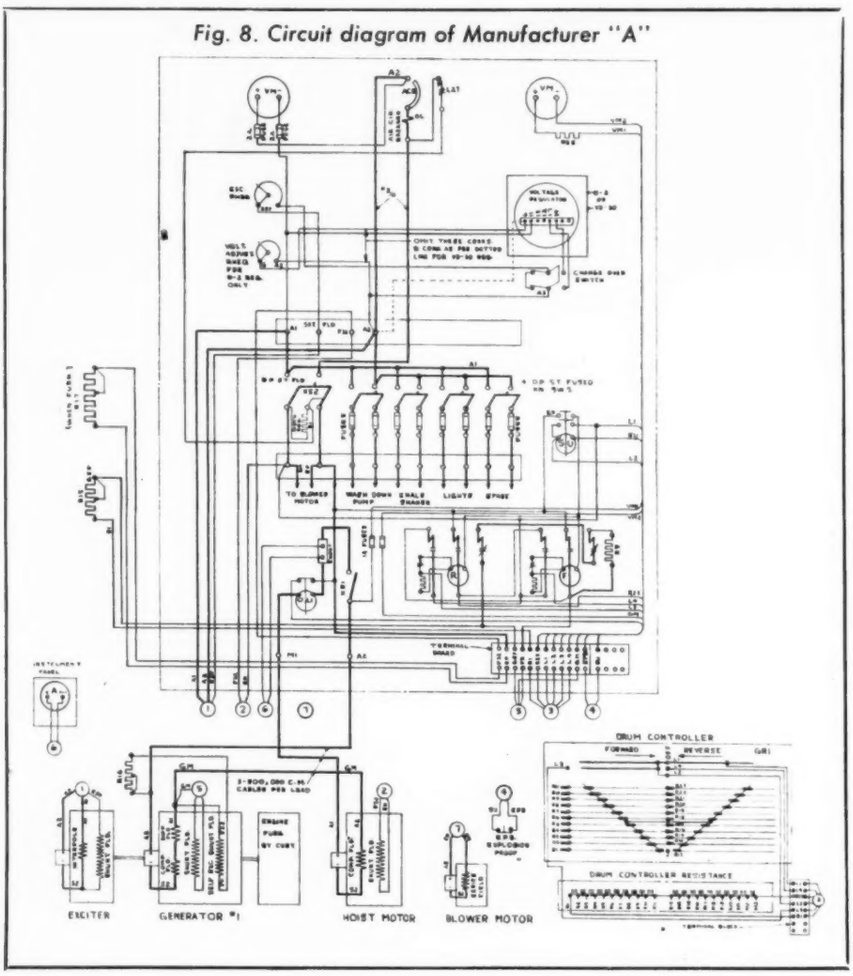
Fig. 9. Schematic diagram of Manufacturer "A"

These armature circuits make use of the so-called "common lead" principle, which enables heavier or lighter armature cables to be carried in those sections that have need of such wiring because of current variations. The switches themselves are very large double-pole, double-throw switches fabricated out of heavy bar copper. Single-pole armature switches may be used to accomplish the same result, as shown in Fig. 12. The compounding features of this type circuit provide for the concentration of mutiple-generator currents upon the driving motors and afford great power for emergencies.

Rather than arrange remote control for these transfer switch operations, it is best to perform them by hand in the occasional instances in which they are needed. Manufacturers have at times provided complicated relay-controlled magnetic master switches for armature circuit flexibility but they are not needed and are very troublesome in instances of related small circuit failure.

Protective interlocks, actuated by these transfer switches, are installed in series with the generator fields. These interlocks always break the large generator field circuit in case the switches are pulled, and thus prevent any chance of injury to personnel by arcing of heavy currents across the transfer switches. A transfer switch should never be opened unless the generator fields are zeroed, but by the use of interlocks, both the equipment and personnel are protected even if this error is made.

Fig. 8. Circuit diagram of Manufacturer "A"



Generator Field Descriptions

At the present time there are three manufacturers supplying the bulk of the electrical equipment used in drilling operations. All produce machines and controls much alike, the two main differences being in the various types of generator fields used to produce generator characteristics, and the complexity of their Ward-Leonard field control system.

To obtain the proper volt-amperage relations from the machines the properly built generator will use a field in one of the following general types:

1. Adjustable shunt field (Ward-Leonard controlled).
2. "Pickup" shunt field.
3. Interpole series field.
4. Differential series field.

The secondary, or so-called "pickup" shunt fields, which are actuated by the adjustable shunt fields, help in mould-

The River of Oil

500,000 barrels of crude petroleum—30 miles from a railroad!

That was back in 1860—a year after Colonel Drake's first well began to produce riches, on Oil Creek, near Titusville, Pennsylvania.

The transportation problem was tough. But boats, barges, rafts—thousands of them—were pressed into service to form a veritable river of oil—down Oil Creek to the Allegheny to Pittsburgh.

Into this picture of river traffic, with its wild uncertainties and fluctuating costs, came the pipe line. It was one of the first oil field services filled by Spang Pipe, made since 1840 in the first pipe mill west of the Alleghenies.

Today, billions and billions of feet of Spang Pipe—now a National Supply Company product—are giving dependable service in oil fields, pipe lines, ships, all kinds of industries, homes, and other installations throughout the world.

All products of The National Supply Company have marched hand in hand with the ever-pioneering, ever-growing oil industry. National Oil Field Machinery and Equipment have been important factors in the development of every oil field in the world. National-built Superior Oil Field, Industrial and Marine Engines are internationally famous for their power and economy.

The National Supply Company serves industry and the individual everywhere . . . and will be an important factor in the peacetime expansion of tomorrow.

★ ★ ★

The National Supply Company

Executive Offices: Pittsburgh, Pa.

General Sales Offices: Toledo, Ohio. Division Offices: Ft. Worth, Texas; Tulsa, Oklahoma; Torrance, Calif. Export: The National Supply Corporation, 30 Rockefeller Plaza, New York, N. Y., U. S. A.; River Plate House, 12 South Place, London, E.C. 2.

SAVE PARTS and STEEL

CONCENTRATE CONTROL with the GRAY COMPOSITE MANIFOLD

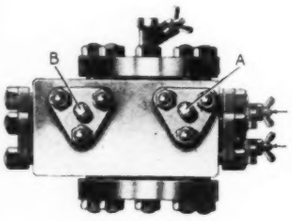
The Gray Composite Manifold is a Christmas Tree and flow line manifold all in one. Concentration of parts in this Composite Manifold effects true economy and saves steel without sacrificing control. It contains four valves and two chokes—all removable—mounted into a single unit. This manifold replaces 4 valves, 2 chokes, a cross, 2 unions, 5 T's, 4 bull plugs, 10 nipples—28 separate parts in the conventional tree.

The Gray Composite Manifold is 345 lbs. of concentrated control, as against the conventional Christmas Tree, weighing 600 to 1,500 lbs. This Gray Composite Manifold is a 2-wing Christmas Tree. You can change chokes without stopping flow from the well.

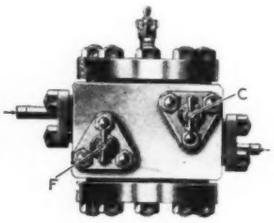
The views above show all sides of this Composite Manifold, which contains two independent flow passages with a common inlet from the tubing and a common outlet for the flow line. One of these passages is at the upper level, the other at the lower level. The valves, plugs, and choke in the upper level communicate with one passage. Valves, etc. at the lower level communicate with the other passage.

To change chokes in the upper level, close Valves A and B, then remove Plug C. To change chokes in the lower level, close Valves D and E, remove Plug F. Valves A and D correspond to the wing valves on a conventional Christmas Tree. Valves B and E correspond to flow line valves, which are closed when changing chokes. All valves in the assembly are interchangeable.

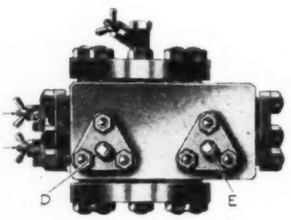
For full details about this steel-saving Gray Composite Manifold and other units in the coordinated Gray Systems of Well Control, write to Gray Tool Company, P. O. Box 1655, Houston, Texas.



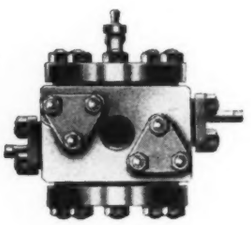
Left Hand Side



Front View



Right Hand Side



Rear View

Concentrated Control with the Gray Composite Manifold

GRAY
TOOL COMPANY
HOUSTON, TEXAS

West Coast Distributor: WAGNER-MOREHOUSE, INC., Los Angeles
Export Representative: GUY E. DANIELS, 30 Rockefeller Plaza, New York City

TO SAVE NATURAL RESOURCES AND CRITICAL MATERIALS IN PEACETIME MAKES GOOD BUSINESS SENSE; TO SAVE NATURAL RESOURCES AND VITAL MATERIALS IN WARTIME BECOMES A PATRIOTIC OBLIGATION.

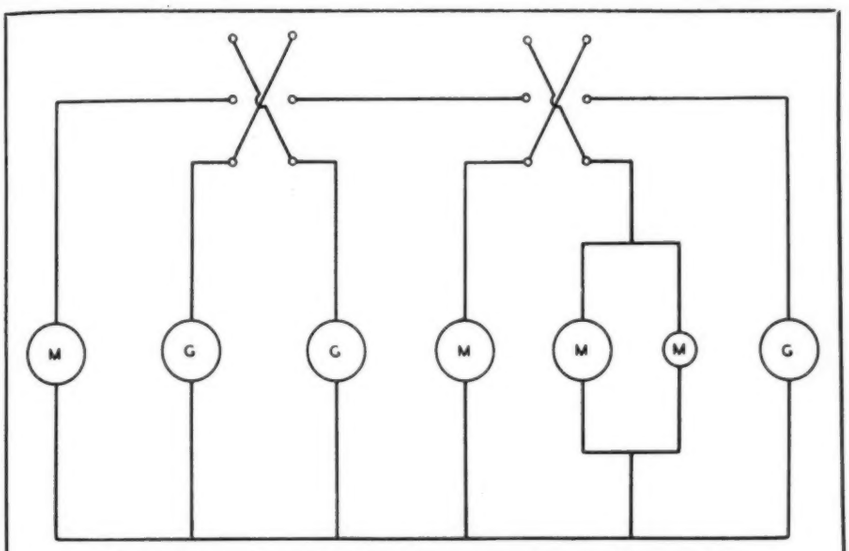


Fig. 10. Transfer switch for three generators and four motors

ing characteristics, whereas the interpole fields smooth out commutation action. The differential series field acts in opposition to the shunt fields, and as the armature current rises, it tends to lower the generator voltage. The ultimate result of differential field action is protection of the prime movers, as a balance is made between the amperage and voltage, and a maximum power level, depending upon prime mover rating, cannot possibly be exceeded even if the electric driving motors become stalled.

Manufacturers "A" and "B" vary the resistance of the Ward-Leonard circuit but do not follow the practice of Manufacturer "C" in including a variable resistance in the secondary "pick-up" shunt field. In the latter design the adjustable resistance element of the secondary field is tapped by contacts on the corresponding generator field controller so that the power generator attains desirable characteristics. The resistance of both primary and secondary shunt field circuits are varied by the same throttle field controller, the primary field being energized by the exciter while the secondary is shunted directly across the power generator armature. Reference to Figs. 12 and 14 will explain the relation of the two variable fields.

In paralleling generator field circuits to allow generator compounding in parallel, Manufacturer "C" also automatically provides for optional use of resistance elements by various generator fields. Upon failure of any throttle resistance element, any of the other resistance elements may be used with the desired generator field. This feature necessitates the use of additional switches (Nos. 9, 10, 11, 12, 13, and 14 as indicated in Figs. 12 and 14) and adds somewhat to the complexity of control even though the circuits are included within the control cabinets.

All three manufacturers are able to construct specially built controls to customer specifications. However, they naturally attempt to design along lines of established policy as regards specifications of their related equipment used in other industries. This adherence to designs and devices used in analogous controls is at times impracticable because it is impossible to give oil-field electrical equipment the care so easily lavished upon permanent installations.

Sturdiness and simplicity should be emphasized in oil-field control and it should be remembered that complexity is very baffling to all but trained electricians. It is almost impossible to have well-trained technicians on duty 24 hours a day to man the involved controls electrical designers often recommend. There has been a steady trend toward simpler controls since they have proved so adequate to meet field requirements.

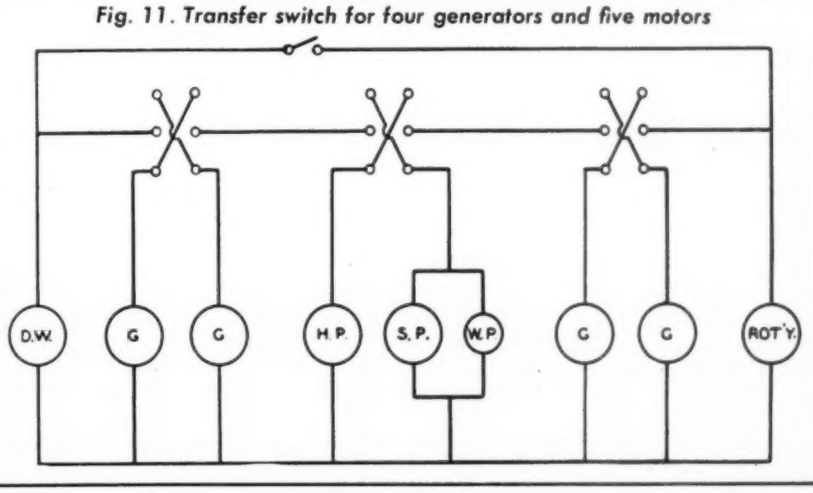
Generator shunt field currents range from 12 to 28 amp. in generators of from 250 to 500 kw. at full load, the amounts varying a great deal depending upon manufacturer, and type of insulation and design. High field current machines are to be avoided if small field current machines of the same rating are available. Regardless of claims of superior insulation, high field current machines have more frequent coil failure, and in most instances have less reserve for overloads.

It is possible to "soup up" any generator by raising its shunt field currents, and this practice is followed by some manufacturers who make it a point to crowd every possible watt out of their machines. Machines that have rated shunt field currents close to the ultimate capacity of the circuit are not to be recommended.

Permanent resistance elements of various types are usually installed by the manufacturers within the field circuits. Adjustment of these resistances is necessary upon initial installation in order to limit and control the maximum generator field current. At times such resistors are integrally incorporated within the generators, but usually some part of them will be installed in the exciter control cabinets where they can be easily inspected and adjusted.

If sufficient technical help is available these permanent field resistances should be adjusted at intervals in order to make provision for necessary load fluctuations. In surface hole and shallow digging much lower field currents are able to supply sufficient power, and a skilled rig electrician will be able to make allowance for needed power demands in such a fashion as to take best possible care of electrical equipment. Frequent adjustment of permanent resistance is not necessary, but increases up to maximum field current capacity as the power demand increases will result in more adequate coil protection. Such proper maintenance of field controls and coils will enable the circuit to stand

Fig. 11. Transfer switch for four generators and five motors



emergency overloads with much greater ease.

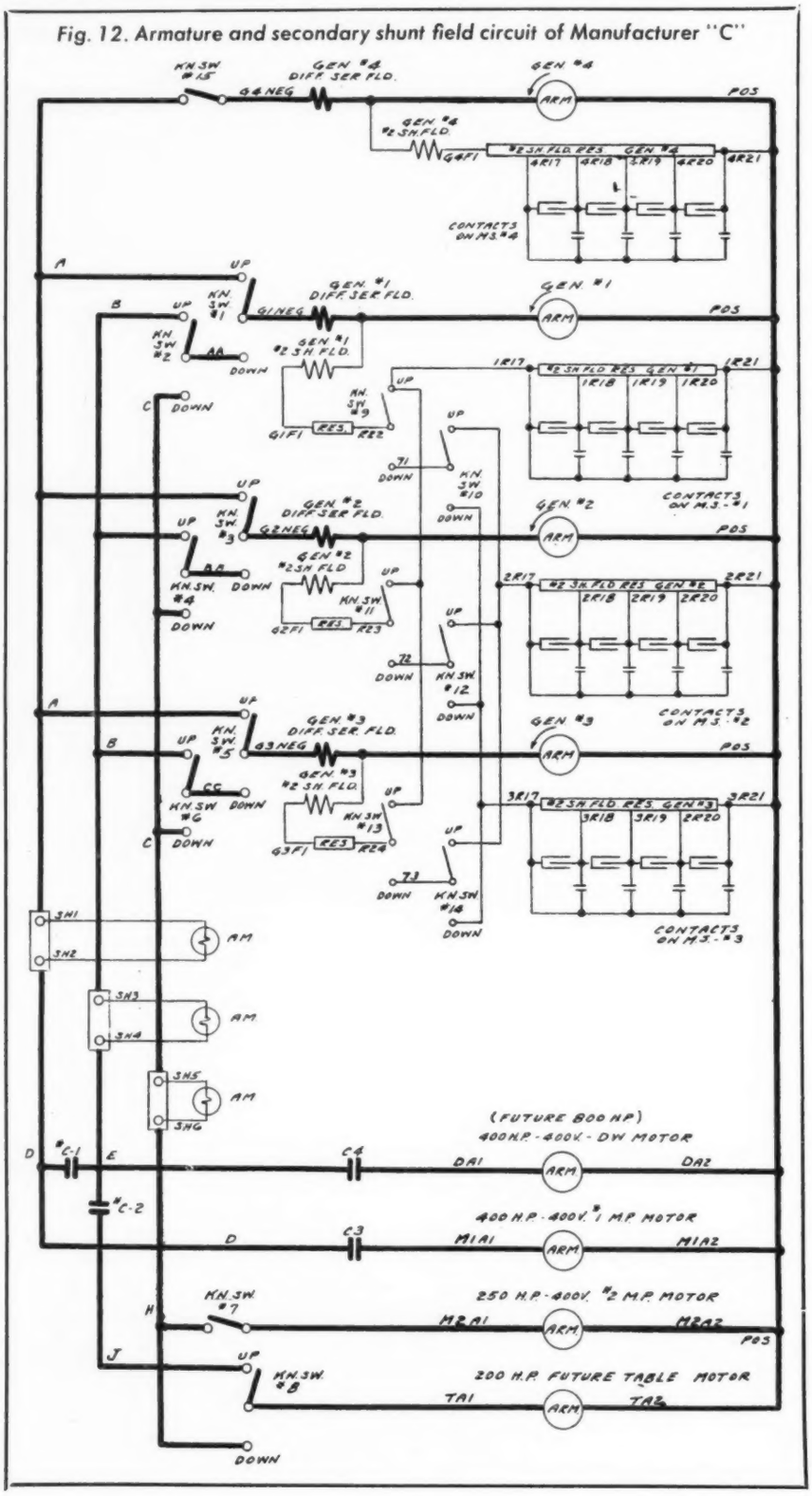
Exciter Generators

At least two 125-volt, 25-kw. exciters should be used on an electric rig, in order that excitation will be available so long as any generative equipment is rotating. The various small power loads about the rig should be split between the exciters, with provision being made so that any of the machines can handle the necessary emergency loads.

Exciters are called upon to handle the following loads:

1. All generator fields.
2. All electric driving motor fields.
3. Water pump fields.
4. Electric driving motor blower motors.
5. Water pump blower motors.
6. Floor bug blower.
7. Shale shakers.
8. Lights
9. Auxiliary centrifugal water pumps.
10. Other accessories.

Fig. 12. Armature and secondary shunt field circuit of Manufacturer "C"



Exciters are called upon to handle the following loads:

A small, gasoline-engine-driven, 125-volt, 25-kw. exciter is usually included in an auxiliary unit on large electric rigs. This unit can be wired into the exciter busses to serve not only as an emergency exciter, but can also be driven as an auxiliary grinder motor, etc.

Each exciter should have its control panel, and even if four large power generators are to be used, their controls can be combined into one large exciter cabinet if proper arrangement of the contactors, relays, and other appurtenances is well planned. Each generator needs an individual floor field controller rheostat, but manufacturers have the habit of supplying a control cabinet with each and every generator.

The field control systems may vary in design, but they all accomplish the same result in supplying accessories and providing for power generator field variation. In order to smooth out operations when exciter load varies, voltage regulators must be used; and the increased efficiency stemming from their use more than merits the additional cost.

The oil-field voltage regulators in present use are small, compact instruments comparable in principle to regulators used in other electrical installations. The changing load varies the exciter voltage, which through coil motivation actuates an automatic rheostat in the exciter shunt field. The actions of the regulator are damped either by stabilizing coils activated by voltage drops, or by air dashpots. The rheostat element in the shunt field is sometimes of the rotating carbon sector type, whereas other larger regulators utilize a "shifting-pile" resistance element.

The use of a voltage regulator is very important, as its operation affects the performance of the entire power plant as far back as the prime movers. Much less prime mover governor motion and hunting occurs if the exciter voltage is maintained constant.

Exciter Circuits

The 125-volt output of the exciters is present across the bus on the corresponding exciter panel, some circuits using a breaker before the bus, but most having direct connections.

Two manufacturers use simple circuits for their motor fields, lights, blowers, etc., the generator field alone having any complexity. Manufacturer

These two kinds of wire rope are made in our factory of the same special analysis high carbon steel, the same carefully controlled heat treatment and continuous wire drawing process. As made by our skilled craftsmen both give you plus value.

Yet there is a difference which means money-in-your-pocket. It is this: In ordinary wire rope of any make, the wires are "laid" into position without first being relieved of stresses set up through changing wires from straight to helical or spiraling shapes. Under these unresolved stresses, the wires have a strong tendency to fight each other and will fly apart when the seizing wire is removed. This wasted effort cuts down the resistance to bending fatigue of the rope as a whole.

In *Union-formed* wire rope, the method of helical or spiral shaping the wires in it before they become component parts, entirely frees the rope of shaping stresses. Thus preformed, parts lay in their positions in such perfect repose that they will not fly apart—in fact, often must be pried from position. *Union-formed* wire rope, therefore, utilizes its full stamina for maximum resistance to bending fatigue. That is why *Union-formed* wire rope bends more easily. Every wire and every strand pulls together to wear longer.

This is only one of 10 time-saving, money-in-your-pocket advantages of *Union-formed* wire rope. To the limit permitted under conditions of war, Union is striving to satisfy urgent needs outside of war production.

UNION WIRE ROPE CORPORATION
2106 Manchester Ave., KANSAS CITY, MO.
Tulsa • Houston • Chicago • Salt Lake City • New Orleans
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IF YOU ARE NOT ON OUR MAILING LIST send for these bulletins: "ROPE DOPE," "Socketing Wire Rope," "Splicing Wire Rope," "Correct Handling of Wire Rope," and "Wire Rope Lubrication." Engineering information supplied without obligation. G-43

UNION WIRE ROPE CORP.
union *Wire Rope*
"THE ULTIMATE IN LOW COST WIRE ROPE"

Each ★ Represents Another 6 Months of Star Performance

WAR PRODUCTION EXCELLENCE WILL BRING POST WAR PLUS VALUES

WHEN YOU NEED PREFORMED WIRE ROPE
SPECIFY **union-formed**

"B" uses the double relay system in his blower circuit that is shown in Fig. 13, in order to protect the driving motors from over-heating in case of blower motor failure. The generator field circuit is opened by the relay system if the blower motor armature current fails. The value of this complex safety devise is debatable as the devise itself is at times a source of trouble.

Control Panels

Almost all cabinet and panel wiring is done by the electrical manufacturers, and only direct adjustments of coil voltages, permanent field resistances, contactor points, voltage regulators, meters, and heavy wiring need be done in field assembly of the rig. Because the manufacturers are still working off established general designs such plans should be analyzed before construction begins so that assurance can be had that the electrical rig will be tailor-made to the planned work.

If there is ample time to instruct the manufacturer regarding just what is needed with respect to control and power, much improvement in unitization of exciter control panels can result. In addition to combining and wiring any number of needed generator controls within the two or three exciter cabinets, additional helpful ammeters and voltmeters could be compactly installed in the switchboards.

The following should be indicated by panel meters:

1. Voltages of all exciters.
2. Amperage of all exciters.
3. Field current of each power generator.
4. Armature voltage of each power generator.
5. Armature current of each power generator.

The exciter bakelite panels could be unitized into a light control cabinet with stout I-beam base. The wells and body could be made of steel sheeting and angle iron with flexible roll-up metal doors in front and rear to allow ready access.

Control cabinets should be mounted near the power plant in order to be able to check rapidly changing power variances, but in no case should they be mounted integrally with any of the power units if voltage regulators or other sensitive instruments are to be used. Vibration due to integral connection is too great for delicate mechanisms, and this type mounting has been successful only in the smaller "in-line" generating units.

EDITOR'S NOTE: This article will be concluded in an early issue of *The Petroleum Engineer.*

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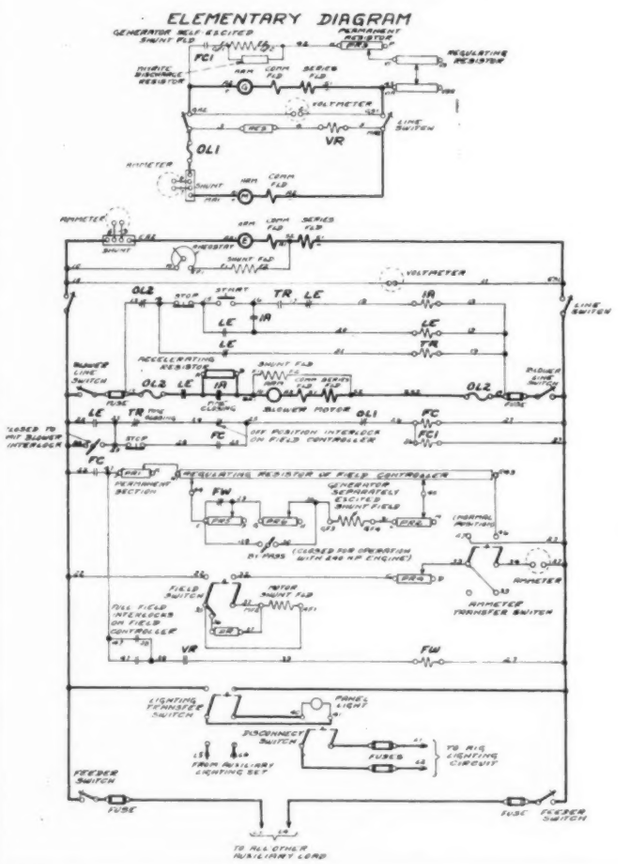
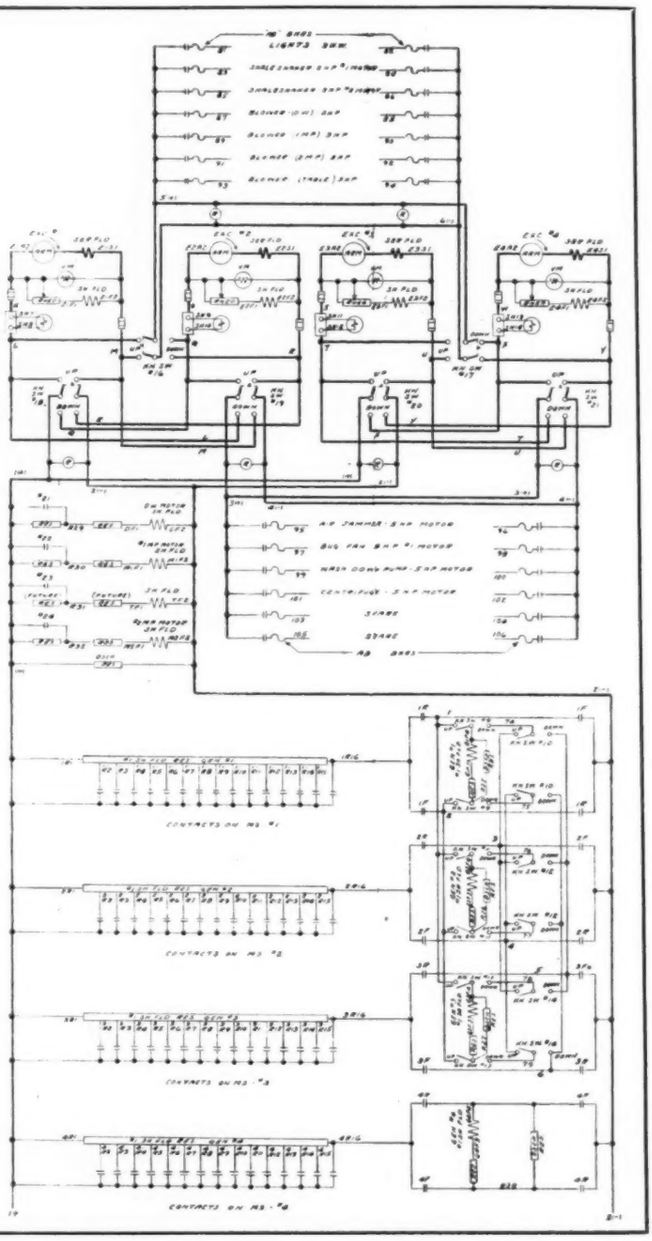
Fig. 13 (below)
Circuit diagram of Manufacturer "B"

Fig. 14 (right)
Exciter circuit diagram of Manufacturer "C"





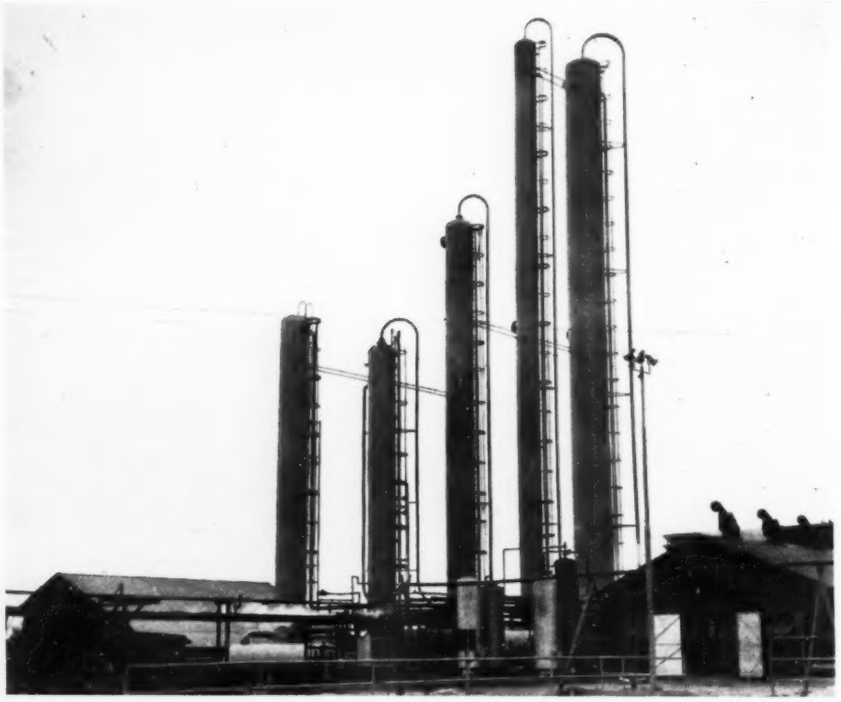
FRICTION OR HYDRAULIC?

To tell whether the job can be done easier, better or cheaper . . . whether the total output of work will be more with a hydraulic torque converter (Lysholm-Smith type) or a hydraulic power take-off than with a friction clutch demands wide experience with both types of power links. That's why you are sure of unbiased recommendations when you submit your problems to Twin Disc engineers.

Twin Disc engineers have devoted over ten years to the research and development of hydraulics. Units covering a wide variety of applications of hydraulic torque converters and hydraulic power take-offs are now at work. In addition they have had over a quarter of a century's experience in adapting friction clutches to all types of power driven equipment.

This engineering experience and factual data is available now while you are planning new products. Two modern factories—one specializing in friction clutches—one in hydraulics—assure economical production when we return to the manufacture of civilian products. Both of these factors . . . competent engineering and adequate production facilities . . . are important to builders of industrial equipment. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES



The five fractionating columns—de-ethanizer, de-propanizer, de-butanizer, butane splitter, and de-pentanizer

PETROLEUM ENGINEER Exclusive Feature

by
Frank H. Love
Managing Editor

Central Fractionating Plant

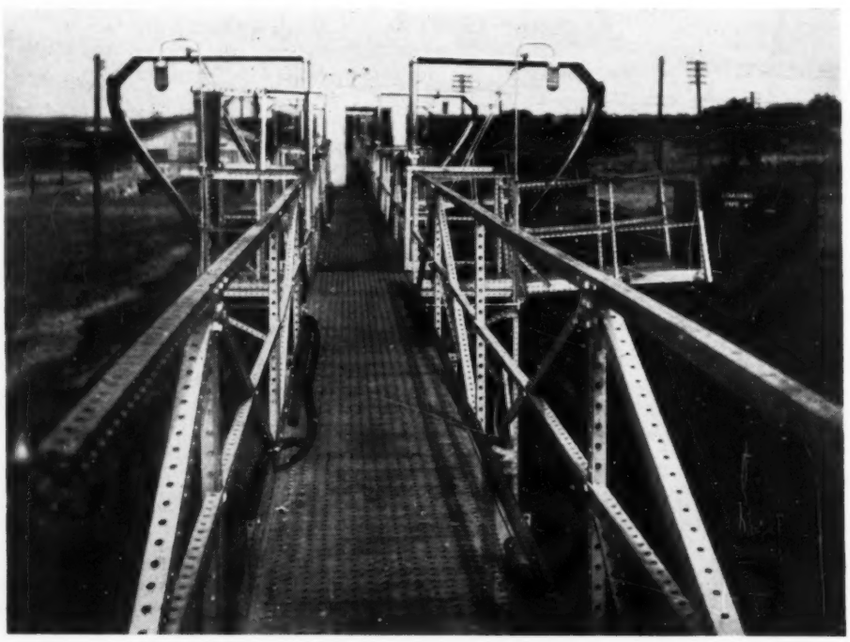
☆ Components for high-octane gasoline manufactured by unit serving absorption-type natural gasoline plants

VITAL and increasing requirements for high-octane gasoline components have prompted the Lone Star Producing Company to construct a central fractionating plant at Ranger, Texas, to serve several absorption-type natural gasoline plants in the area. These plants are the Brooks Plant at Breckenridge, and plants at Ranger, Gordon, Pueblo, and Sipe Springs; a total of five, owned by Lone Star Producing Company and Lone Star Gas Company.

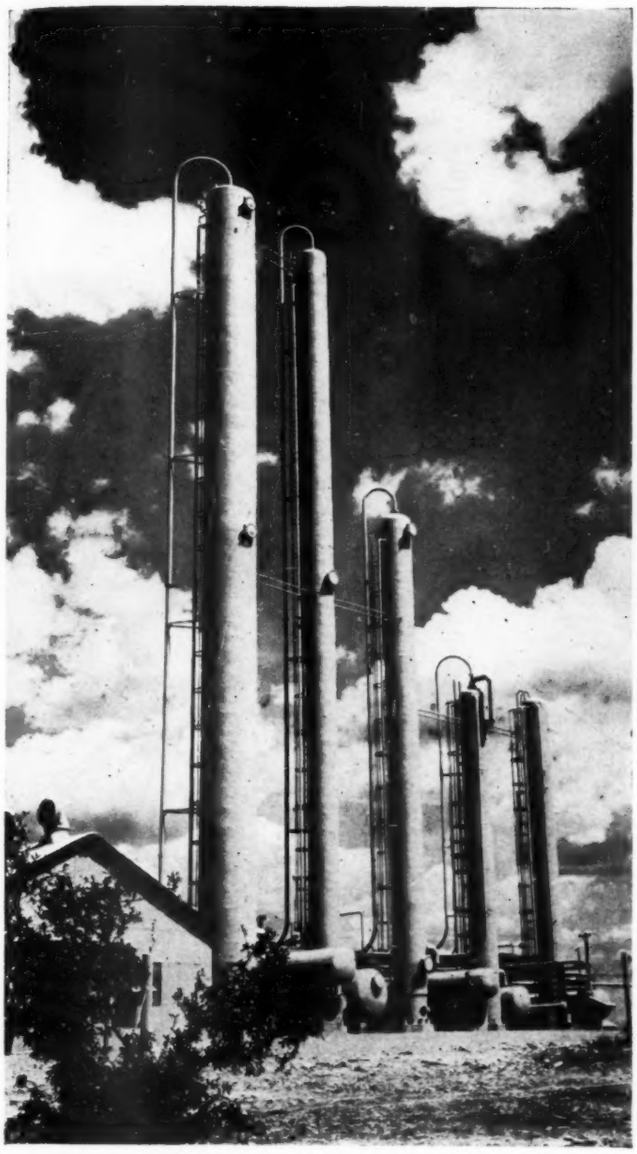
Raw gasoline is brought to the central fractionating tower at Ranger both by pipe line and tank truck, approximately 75 percent by the former method and 25 percent by the latter. The transportation program included the laying of approximately 30 miles of 4-in. pipe line from the Breckenridge area.

Products manufactured are *iso*butane, *iso*pentane, normal butane, pentanes and heavier, commercial butane, and propane, the last being blended with normal butane to produce commercial butane. Pentanes and heavier are blended with normal butane to form various grades of motor fuel and natural gasolines. *Iso*butane and *iso*pentane are sold for use in the manufacture of aviation gasoline.

The central plant was constructed partly of new materials but for the most part of second-hand equipment. Three



Most of the products are loaded into tank cars from this 12-car loading rack. Some commercial butane is shipped by truck

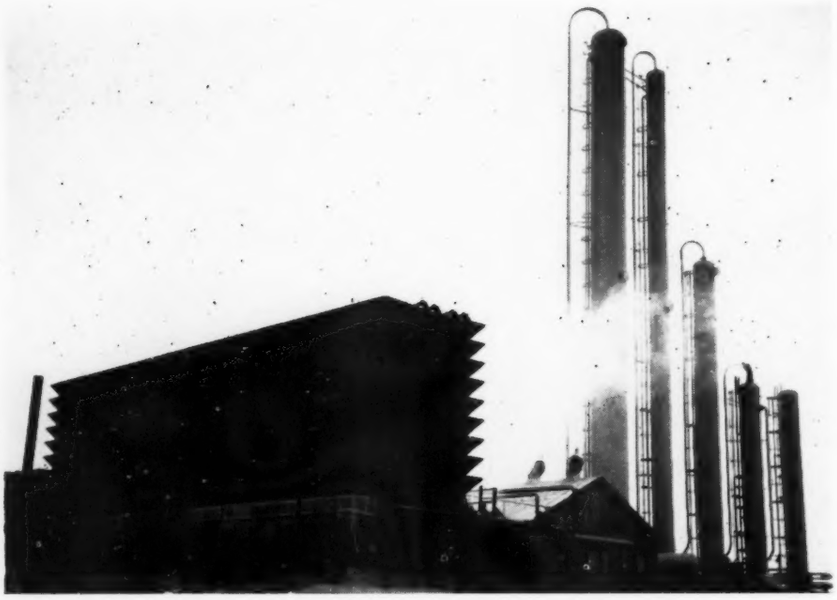


Fractionating Columns
Lone Star Producing Company
Ranger, Texas, Plant

This is one of several plants having multiple column fractionating equipment which include de-ethanizers, de-propanizers, de-butanizers, de-isobutanizers and de-isopentanizers.

Designed and constructed by

GASOLINE PLANT CONSTRUCTION CORPORATION
713 Second National Bank Building
HOUSTON, TEXAS



Atmospheric-type cooling tower that circulates 2000 gal. of water per min.

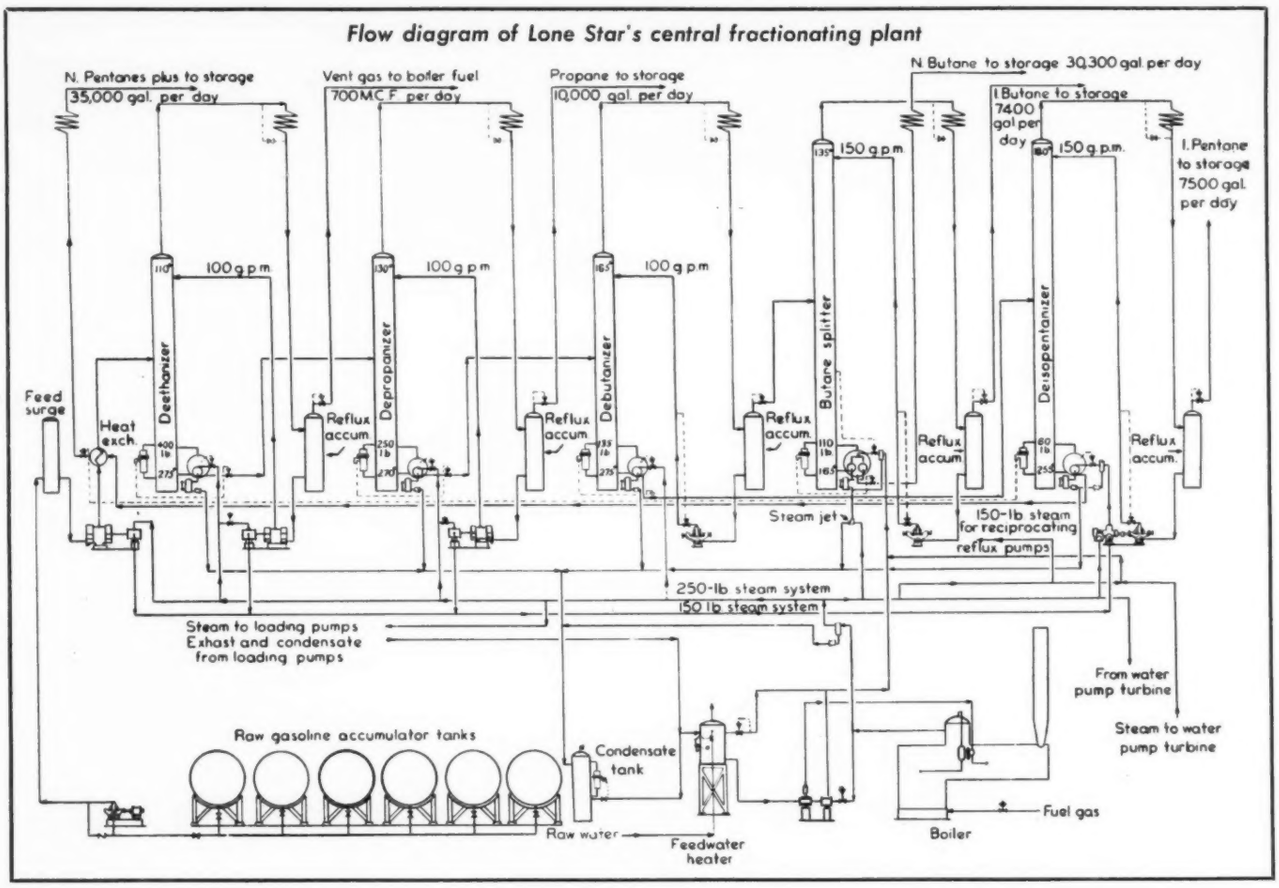
of the fractionating towers are new: the 66-plate de-*iso*pentanizer, which is 7 ft. in diameter by 112 ft. high; the 66-plate butane splitter, which is 4 ft. in diameter by 112 ft. high, and the 30-plate debutanizer, which is 4 ft. 6 in. in diameter by 70 ft. high. The de-propanizer and de-ethanizer columns are second-hand having 30 plates each and are 4 ft. in diameter by 49 ft. high. Among the other salvaged equipment used were buildings, cooling tower, tanks, pumps, boilers, and condensers. Instruments and controls also were salvaged except for a few replacement parts. The 12-car loading rack and other facilities for shipping were already installed at the plant, as well as a laboratory and considerable tankage, which prompted the selection of this particular site for construction of the fractionating plant.

Six 10 by 40 horizontal tanks, each having a capacity of 22,000 gal., serve as raw storage. These are used as working tanks, three for receiving natural gasoline from the various plants, whereas deliveries are made to the fractionating plant from the other three. In this manner uniform feed to the columns is effected.

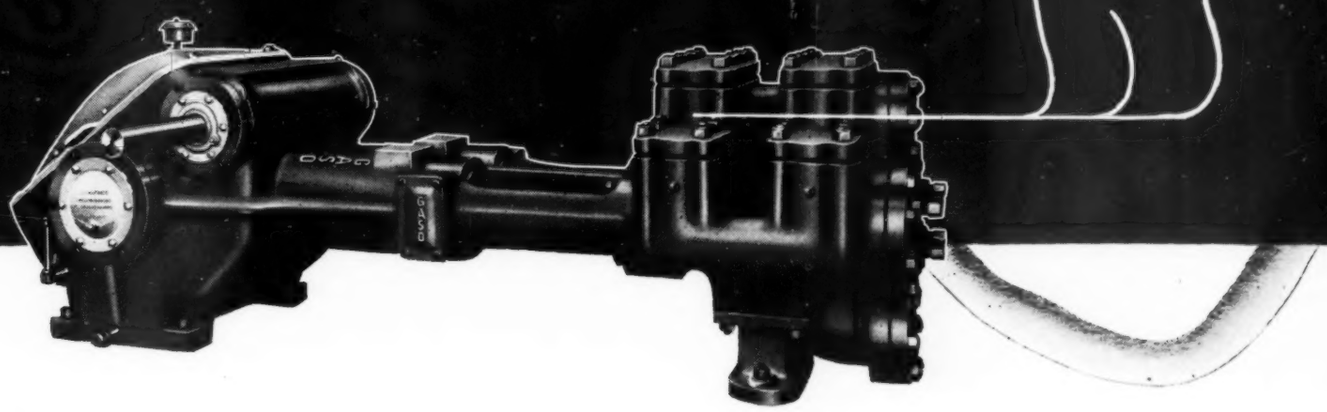
Because the feed tanks are situated lower than the pump delivering to the initial column, a motor-driven centrifugal pump was set in the line to boost to the suction of the feed pump. The booster delivers into a surge tank, from which suction is taken by a close-clearance reciprocating pump, which pumps the raw stock through a set of heat exchangers, wherein it exchanges heat with liquid from the bottom of the de-*iso*pentanizer, into the de-ethanizer. This column is operated at a pressure of 400 lb. with the bottom temperature held at 275°F. and the top temperature at 110°F.

Vapors from the top of the de-ethanizer are used for boiler fuel. The bottoms feed directly into the de-propanizer, operated at 250 lb. with the bottom temperature 270°F. and the top

Flow diagram of Lone Star's central fractionating plant



HEART OF THE WAR MACHINE



IF OIL is the lifeblood of the war machine, then a pipeline pump is its heart — for, like a heart, it pumps a vital fluid through veins and arteries that lead eventually to all theaters of war.

Gaso men know the importance of their product in war operations. In spite of long hours, they are putting an extra measure of pride and precision into their work, knowing that all of their production is directed to the job of winning the war . . . Gaso Pump & Burner Mfg. Co., 902 E. First Street, Tulsa, Oklahoma. Export Office: 149 Broadway, New York. Shreveport: W. L. Somner Co., 419 Lake Street. Los Angeles: Service Oil Field Supply Co., 5333 S. Riverside Drive.

GASO PUMPS

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A partial view of the pumphouse interior

temperature 130°F. The overhead goes through condensers to propane storage. Bottoms pass directly to the de-butanizer. This column is operated at a pressure of 135 lb. Bottom temperature is 275°F. and top temperature 165°F. Overhead from the de-butanizer passes to the butane splitter and bottoms are discharged to the de-*iso*pentanizer. The butane splitter is operated at a pressure of 110 lb. with the bottom temperature 165°F. and the top temperature 135°F. Normal butane comes off the bottom of the column and *iso*butane off the top, each passing through condensers before going to storage.

The de-*iso*pentanizer operates at a pressure of 60 lb.; the bottom temperature is maintained at 255°F. and the top temperature at 130°F. *Iso*pentane goes overhead and pentanes plus come off the bottom.

Product Storage

Product storage consists of three 10 by 40 tanks of 22,000-gal. capacity each, for *iso*butane; seven 10 by 40 tanks for commercial butane; six 10 by 40s for normal butane; six 10,000-bbl. tanks for pentanes plus; 2000 gal. of tankage for propane, and eighteen 7 by 27 auxiliary storage tanks each of which has a capacity of 8000 gal.

Pumps

Pumps are principally of the reciprocating type. The raw feed pump is a 12 by 7 by 18 simplex close-clearance pump; the de-ethanizer reflux pumps, of which there are two, are 10 by 6 by 12, and the de-propanizer pump is the same size unit. A close-clearance simplex pump, 16 by 10 by 18, acts as a standby for raw feed and de-propanizer reflux. The two de-butanizer reflux pumps, two butane splitter reflux pumps, and two de-*iso*pentanizer reflux pumps are 10 by 16 duplexes. A skid unit consisting of three centrifugal pumps serves as a standby for pumping reflux to the de-*iso*pentanizer, butane splitter, and debutanizer. This unit is steam turbine driven.

Steam Plant

Plant steam is provided by four 125-hp. oilfield-type boilers, operated at 200-lb. pressure. Steam condensation is 100 percent.

Water Supply

Water supply is from the Eastland and Olden lakes. The atmospheric-type cooling tower circulates about 2000 gal. of water a minute. Two centrifugal pumps, one driven by a 40-hp. motor and the other steam turbine driven, boost water from the base to the top of the tower.

Shipping

Some commercial butane is shipped by truck; the rest of the products are loaded into tank cars. Separate lines are provided for each product from storage to the loading rack in order that there will be no contamination of one product with another.

Raw Gasoline Analysis

A composite analysis of the raw gasoline received at the central plant is as follows:

Component	*Percent*
Propane and lighter	22.65
*Iso*butane	6.95
Normal butane	26.64
*Iso*pentane	7.98
Normal pentane	10.03
Hexane plus	25.75
	100.00

Contractors

Gasoline Plant Construction Corporation was the contractor in charge of erecting the central fractionating plant. Sharman and Allen laid the pipe lines, and the several fractionating towers were built by Wyatt Metal and Boiler Works.

Harry Wheeldon, superintendent of gasoline plants, and John Kindle, district superintendent, supervised construction for Lone Star.

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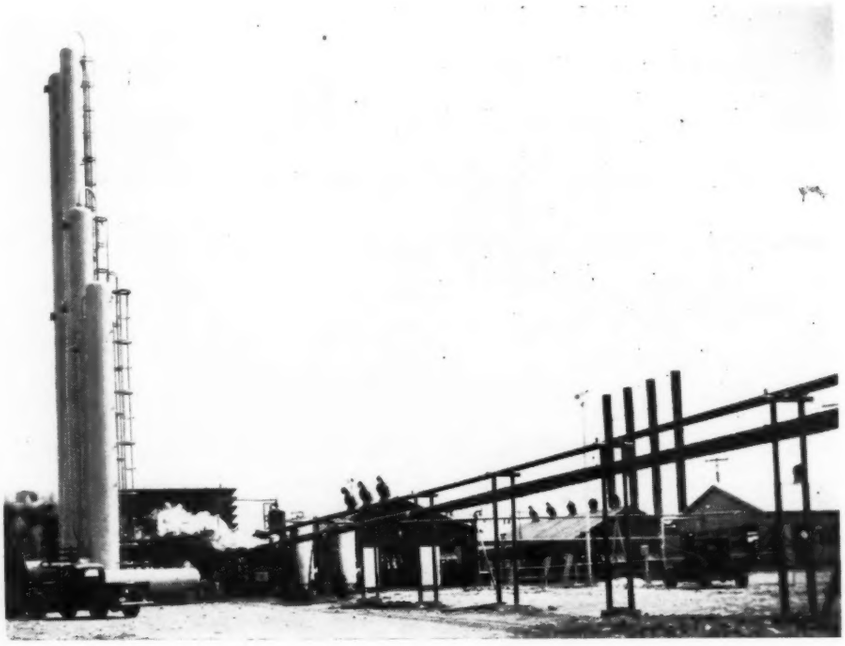


General view of the central fractionating plant

Answers to Your Questions About

THE POSTWAR

CUMMINS DEPENDABLE

DIESEL

Question: We are told that miraculous, revolutionary developments in plastics, electronics, aviation and many other fields of industry merely await the ending of the war. Will this hold true also of the postwar Cummins Dependable Diesel?

Answer: The postwar Cummins Diesel will not be a "miracle" diesel. The dramatic, pioneering stage of diesel development which caught the public's fancy a decade or so ago has passed. But the man who understands diesel engines in relation to the power needs of heavy-duty industry will find many "revolutionary" features about the new models, in the sense that he will be able to use the Cummins Diesel in many new ways and places and equipment . . . and use it at a considerably lower cost than ever before.

Question: Is it possible now to say what new features the postwar models will have?

Answer: Only in general terms. Specific details are at present marked "confidential" for obvious reasons. Then, too, the picture is ever changing—today's specifications might be altered by tomorrow's findings. We can say, though, that these new features apply to almost every phase of design and operation . . . cooling, lubrication, material specification, etc. *All changes will have the vitally important over-all effect of increasing horsepower output per pound of engine weight . . . simplifying and reducing maintenance requirements . . . extending the engine's efficient "work life."*

Question: Is the development of postwar models being carried on as an independent project, separate and apart from Cummins' production-for-war program?

Answer: No. Just prior to the war, we completed one of the finest diesel research laboratories in the country. We expected to use it exclusively for the development of future models. But with the coming of war, this laboratory—like every other facility we possess—was turned over to research projects directly connected with our present production for the armed forces. For example: scarcity of a certain metal or alloy may threaten production. The lab turns to a search for a substitute, frequently comes up with a material better than the original. Or, certain engines may be destined for service where extreme and unusual operating conditions exist. In the laboratory, these specific problems are solved, perhaps by a minor change in cooling or lubrication, and this change may be worth incorporating on all models. *Thus it is that the improvements and refinements you will find on your postwar Cummins Diesel are the direct result of our efforts to give our fighting forces the best fighting tools we know how to build.*

Question: Will postwar models make current or prewar models obsolete, from the standpoint that parts for old engines will not be available in the future—or interchangeable with parts for new engines?

Answer: No. It has always been a cardinal point in Cummins policy to assure the continued operation of the engine by providing replacement parts, regardless of how old the engine may be. Furthermore, we are constantly trying to reduce the owner's maintenance problems and we know from experience that one of the best ways of doing this is by preserving the interchangeability of parts to the furthest extent consistent with sound design and operating efficiency. It has never been in our scheme of things to make an annual event of "new models." Improvement and refinement are a painstaking, continuing process. True, war has greatly stimulated this process . . . enabled us to do ten years' work in one or two. But war has in no way swerved us from our purpose . . . which is to make each day's Cummins Diesel better than the day's before . . . *but* to make every owner who bought a Cummins Diesel *yesterday* glad that he owns it *today*.

MID-CONTINENT SUPPLY COMPANY

FORT WORTH, TEXAS

Distributors Mid-Continent Territory

CUMMINS ENGINE COMPANY • COLUMBUS, IND.

STOODY 6
Applied by Welding Reclaims Worn Valves

NOW worn valves, valve parts and pump sleeves can be reconditioned to outperform new factory parts by a simple oxyacetylene welding application using Stoody 6. This new Stoody alloy, composed principally of cobalt, chromium and tungsten, will not oxidize—even under intense heat, has high impact strength in relation to its hardness, offers excellent resistance to abrasive wear, and is perhaps the easiest of all hard-facing alloys to apply. Stoody 6 is highly efficient for hard-facing new or old internal combustion exhaust valves, gate, globe and angle valves, hot oil pump sleeves, etc.

Trial order of 10 lbs. of 3/16" diameter Stoody 6 at $4.25 per lb. will prove the merits of this alloy for any applications involving heat, corrosion, abrasion and impact. Available on AA-4 or higher priority rating.

STOODY COMPANY
1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear . . . Eliminate Repair

LAUGH WITH BARNEY

A traveling salesman was registering at a small hotel and a bedbug crawled slowly across the page.

"Well," he said, "I've been bitten by all sorts of bugs in all sorts of hotels, but this is the first time I've ever seen a bug crawl down to see what room I'll be in."

Due to the frequent bombings, there was a time when civilian casualties were heavier in England proper than in the armed service. On one occasion rescuers spent several hours digging out the occupants of a bombed cockney household. When finally a mother and several children had been carried to safety, the air raid warden looked anxiously back at the wreckage and turned to the rescued woman.

"Was your husband in there?" he asked, pointing to the house, now just a pile of rubble.

"My 'usband?" the woman snapped contemptuously. "Oh, 'e's safe all right. The bloody coward; 'E's enlisted!"

Two fellows were discussing this and that on the street corner one day, when the talk got to clothing.

"Nice suit you got there," says one.

"Sure is," says the other proudly. "For this suit, the wool was made in Australia, the thread was made in Great Britain, the garment itself in Rochester, New Yawk."

"That's amazing!" says his friend.

"And that's not all," went on the wearer. "I bought this particular suit of clothes in a store in San Francisco."

"Incredible!" says his friend.

"Wait a minute," says the other. "The most incredible part of all is how so many people can make a living out of something I haven't even paid for yet!"

Two Nazis were standing on a street corner in Berlin. They noticed a man coming down the street.

"Look at that guy," said the first one. "Has he got a dumb look on him. Just like an idiot. Look at the hair dangling over his eyes like a shetland pony."

"What are you saying!" snapped his friend. "That's Hitler!"

"You know," said the first Nazi, "it's a funny thing—on him it looks good."

Air Raid Warden: I'm awfully sorry, old man, that I arrested you for kissing a woman in the blackout. I didn't know it was your wife.

Man About Town: Oh, that's all right, Warden, I didn't know it either until you flashed that light in her face.

A woman arrived for the wedding late. As she came rushing up to the door, an usher approached her for her invitation.

"I have none!" she snapped.

"Are you a friend of the groom?" asked the usher.

"Certainly not!" the woman replied vehemently. "I'm the bride's mother!"

A landlord called for his rent, many weeks overdue. He was naturally very annoyed when the tenant explained the unhappy state of affairs.

"I'm really very sorry," said the tenant, "but I just can't pay you this week."

"But you said that last week!" cried the landlord. "And the week before and the week before!"

"Well," said the tenant, "and didn't I keep my word?"

A Mississippi steamboat was stopped owing to a dense fog. A nosey passenger inquired the cause of the delay.

"Can't see up the river," said the captain laconically.

"But I can see the stars overhead," the passenger came back sharply.

"Wal' " said the captain, "unless that loose boiler busts we ain't going that way."

"What is a fox?"

"A fox is a wolf who sends flowers."

Talkative Lady: A big man like you might be better occupied than in cruelly catching little fish.

Fisherman: Perhaps you're right, lady. But if this fish had kept his mouth shut he wouldn't be here.

"What did your uncle die of, Mrs. Flanagan?"

"Gangrene, Mrs. Malone."

"Thank hivins for the color, anyway, Mrs. Flanagan."

"Like to see a model home?"

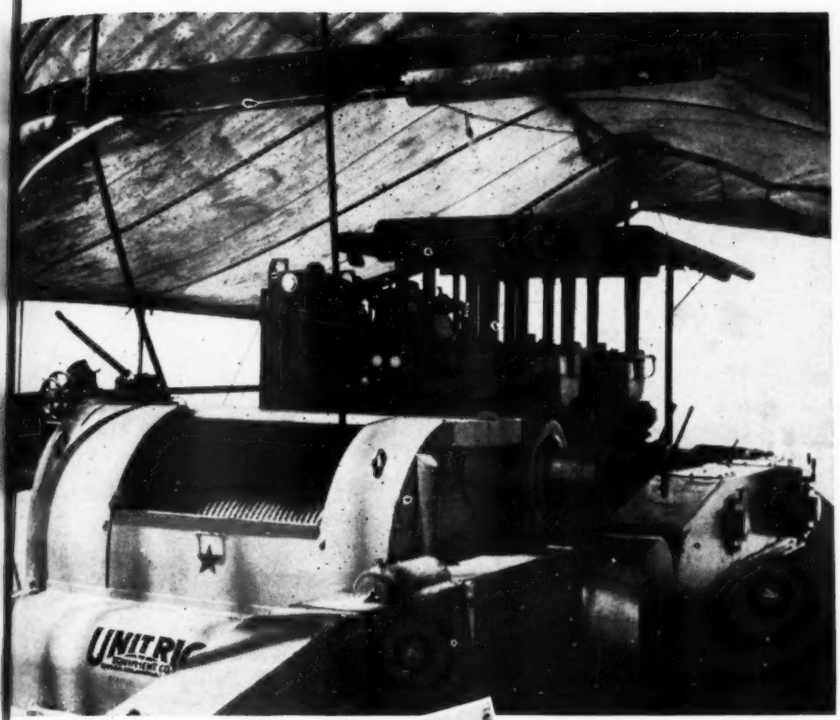
"Glad to. What time does she quit work?"

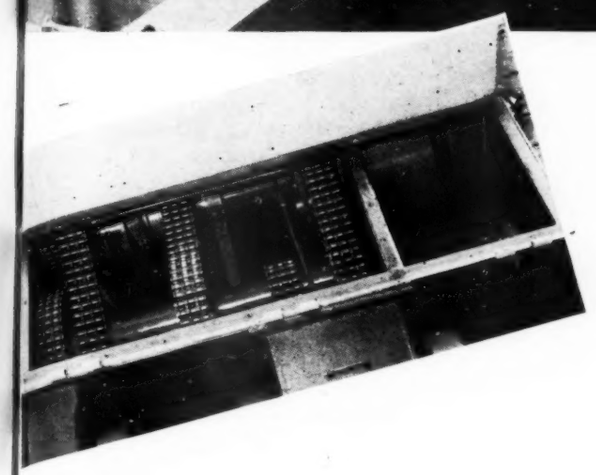
A Scotchman had been complaining of insomnia. "Even counting sheep is no good," he sighed. "I counted 10,000, sheared 'em, combed the wool, had it spun into cloths . . . made into suits . . . took 'em to town . . . and lost $21 on the deal! So I haven't slept for a week."

"Lighthouse no good for fog," says an Eskimo. "Lighthouse he shine, whistle he blow, fog bell he ring—and fog he come in just the same!"

STREAMLINED

COMPACT and POWERFUL





☆ *Above is illustrated the U 10 Spitfire. This rig will drill to 6500 feet.*

☆ *Lower photo illustrates UNIT RIG transmission with Air - O - Matic Clutches, showing simplicity, accessibility and interchangeability of parts.*

☆ *Back up the attack with your purchase of War Bonds!*

the UNIT RIG AIR-O-MATIC CLUTCH JOINS Fighting Forces

Years of heavy duty oil field service as a vital part of our U 10 Spitfire Drilling Rigs and U 24 Service Hoists have proved the dependability and efficiency of Air-O-Matic Clutches. No other drilling rig can point to a better record of performance under such difficult conditions.

Recognition of the flexibility of operation and control of the Air-O-Matic Clutch has been made by U. S. Government Engineers responsible for the purchase of vital war materials. Hundreds of Unit Rig transmission units embodying Air-O-Matic Clutches are being produced for duty with our armed forces.

UNIT RIG Drilling and Well-Servicing equipment is available in limited quantities under existing purchase regulations. Further data and information will be gladly furnished direct, or through your dealer.

☆ BUY UNIT RIG EQUIPMENT THRU YOUR FAVORITE SUPPLY COMPANY

UNIT RIG & EQUIPMENT CO.

TULSA OKLAHOMA U.S.A.

ORBIT VALVES

The Valves that can "Take It"

ORBIT MASTER VALVE

The Orbit Master Valve is quick opening—has easy operation and a positive shutoff. A welded bonnet valve—insurance against possible gasket leaks.

YOUR ORBIT VALVES

will last for the duration. Meanwhile, if you have any questions regarding their care or maintenance, write us.

OIL WELL IMPROVEMENTS CO.

Since 1912

TULSA, OKLAHOMA

Running Tour

WITH MEN IN THE INDUSTRY

FRANCIS MARION LONG, 52, veteran oil field drilling contractor, died August 25 at his home in Humble, Texas. Since his youth Long had been an independent operator in Texas fields. He was head of his own organization, the F. M. Long Drilling Company.

W. L. STEWART, Fort Worth, Texas, has signed a contract with the state of Alabama under which he will conduct explorations for oil, gas, sulphur, and other minerals in the state's intercoastal waters. The contract provides that Stewart shall make surveys by geophysical or other methods in bay, sound, and Gulf bottoms.

HARRY AGGERS has been promoted to West Texas district production superintendent for Union Oil Company of California. He was in charge of production for Union in the Dominguez district of the Los Angeles Basin in California.

R. D. EVANS has been transferred from the Phillips Petroleum Company refinery at Okmulgee, Oklahoma, to the firm's refinery at Borger, Texas, where he will fill the post of superintendent. He succeeds the late E. H. BENDER who was killed in an airplane accident.

HAROLD E. REED has been appointed vice-president in charge of production for Engineering Laboratories, Inc., Tulsa, Oklahoma. With 15 years' production experience Reed has been previously with Frigidaire Corporation and later he was production manager of Cessna Aircraft Company in Kansas.

Harry D. Hampton of Houston, Texas, has been placed in charge of field operations for Byrne Drilling Contractors, a new Dallas concern, which has been operating as general construction contractors for several years. Hampton will have temporary headquarters in Graham, Texas.

Charles T. Miers has been promoted to assistant district superintendent for Humble Oil and Refining Company, Maurbro district, Texas.

C. N. GUERASIMOFF, formerly assistant chief engineer, has been appointed by H. G. SMITH, executive engineer, to position of chief engineer of the Engine Division of the Buda Company, Harvey, Illinois. Guerasimoff has been with the Buda Company for the last 9 years during which time he has served as mathematician, engineer on stress analysis, and design engineer on gasoline and Diesel engines. In 1941 he was appointed assistant chief engineer in charge of the Radial Diesel Engine Division.

L. E. HAMMER has joined Worthington Pump and Machinery Corporation as assistant works manager of its Moore Steam Turbine Division, Wellsville, New York. A 1923 graduate of the University of Pittsburgh, his experience has been chiefly in the field of steam turbine manufacture.

E. DEGOLYER and MORTIMER KLINE have resigned from the Petroleum Administrator for War to take positions with the Petroleum Reserves Corporation. DeGolyer, who has been an Assistant Deputy Petroleum Administrator, will become consultant of Petroleum Reserves. Kline, who has been PAW's associate chief counsel, will become general counsel of PRC. The Petroleum Reserves Corporation was established recently as an agency that will concern itself with foreign petroleum matters. Harold L. Ickes is president.

CECIL DAVEY has been elected vice-president and general manager of Everlasting Valve Company, Jersey City, New Jersey. He started with the company 32 years ago, in 1911. In 1916, he was made plant superintendent and later was also placed in charge of purchases.

ALBERT E. PIERCE has been promoted to general manager of production for the Mid-Continent Petroleum Corporation and he will also serve on the board of directors. He was district superintendent in the greater Seminole field before he was made assistant to the late GEORGE O. MOODY, then general manager with headquarters in Tulsa.

BENJAMIN MILLER, expert on gas transmission, has been appointed to the staff of the Institute of Gas Technology at Illinois Institute of Technology. Associated with the Cities Service System for the last 15 years, Miller was formerly consulting engineer and assistant to the president of Gas Advisors, Inc., a service company in Cities Service. In his new position, Miller will conduct advanced research and teach gas technology. The author of several articles on pipe line flow for the trade and technical press, Miller has been granted numerous patents on inventions in the fields of oil and gas technology.

PAUL DIETZ has been appointed export sales manager for the general machinery division of the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, it is announced by WILLIAM C. JOHNSON, general sales manager. Dietz comes to Allis-Chalmers from the export division of the B. F. Goodrich Company, Akron, Ohio. During the 15 years he was with Goodrich, Dietz was stationed in Mexico, China, and French Indo-China. He was in Hong Kong when it fell to the Japanese, returning to this country following negotiations between the State Department and the Japanese government.

RAYMOND B. KELLY, of Olney, Illinois, has been appointed the Petroleum Administration's director of production in the Midwestern States (District II). He will be stationed in PAW's Chicago office. The new district director has been in the oil business for 24 years. Widely known as a production executive and petroleum engineer in the Southwest and Midwest oil fields, he assumes his new position with an intimate understanding of production problems in the Mid-Continent region. Kelly is now on leave of absence from the Pure Oil Company, where since 1939 he has been division manager in charge of production operations in Illinois, Indiana, and Kentucky.

FRANK C. HENDERSON, 85, who built the first natural gasoline plant in Oklahoma, and later constructed plants in Texas and other states, died August 26 at his summer home at Hot Springs, Virginia.

GAVIN S. YOUNKIN, who has been liaison engineer for Brown Instrument division of the Minneapolis-Honeywell Regulator Company with its customers in the petroleum and chemical industry on the West Coast, has taken on additional duties. He will also be manager of the Los Angeles district office of the San Francisco branch, according to an announcement by L. MORTON MORLEY, vice-president and sales manager.

THE OIL INDUSTRY WILL ALWAYS BE OUR NO. 1 CUSTOMER, BUT

VICTORY FIRST!

A milling machine was needed for this job, but all O-C-T milling machines were tied up on other jobs for the Maritime Commission. So an idle slotting machine with a small electric motor to drive the cutter got the job done. Another example of O-C-T ingenuity!

First things come first. Right now, winning the war takes precedence over everything else and we have dedicated our entire resources to that goal. Accordingly, you might be asked to wait for that O-C-T blowout preventer, valve, well head or fitting; or you might be asked to buy repair parts that will enable you to make your old equipment serve your needs temporarily. In any event, we want you to know that we haven't thrown you over for a new and bigger customer . . . that we sincerely appreciate your patronage which has enabled us to grow and be of real service to our country in time of distress . . . that you will always be our No. 1 customer.

O-C-T proudly flies this prized Treasury Flag because 100% of O-C-T employees are buying war bonds and stamps.

QUALITY O-C-T PRODUCTS "Selling Through Leading Supply Stores"

OIL CENTER TOOL COMPANY

HOUSTON, TEXAS, U.S.A.

Export Representative: Val R. Miller, 30 Rockefeller Plaza, New York, N. Y.

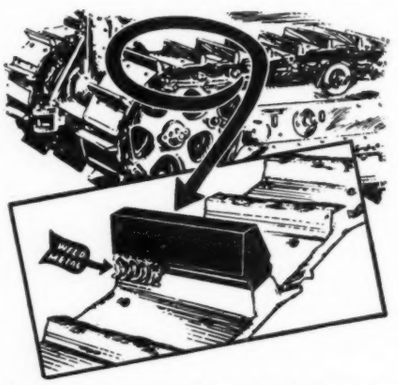
MACHINERY and EQUIPMENT

Tractor Grip-Lug

WITH many tractor owners overhauling their equipment, and the difficulty in procuring repair parts, or the delay ensued in waiting for delivery of such parts, contractors will welcome the news of a recent development of the Allied Steel Products, Inc., Cleveland, Ohio, of their Bulldog brand tractor grip-lugs.

Worn grousers on tractor-shoes cause tracks to slip and slide over the terrain with resultant loss in traction efficiency, fewer and smaller loads per day, increased cost of handling—besides delay and loss of valuable time on other equipment on the job.

It is now unnecessary to tear down the track assembly and replace the worn grouser-shoes with new parts, when a simple repair operation will restore the "gripping power" of the track. This is accomplished merely by welding on to the old grouser-shoe a specially designed steel bar with a groove and bevel to



facilitate laying welding bead along the edge that holds the bar and the grouser-shoe together as in a vise. The material is a special analysis work hardening steel that gets harder and tougher with use, and often outlasts the original grouser. More than 80 percent of the metal of the old shoe is thus salvaged, releasing that much critical metal for urgent government needs. Meanwhile, the contractor has put his tractor back into good condition at considerably less replacement cost and without delay. New and informative literature has just been issued describing the material and methods of application, free upon request.

Multiple Unit Electrically Heated Combustion Furnace

INCIDENT to the stepped-up production of high-octane aviation gasoline essential to the war program, the Universal Oil Products Company of Chicago, Illinois, has developed a multiple unit electrically heated combustion furnace offering several novel features. The equipment is manufactured and offered commercially by the Precision Scientific Company, 1750 North Springfield Avenue, Chicago, Illinois, through coöperation with the Universal Oil Products Company.

Although originally designed specifically for the determination of carbon on cracking catalysts used for producing high-octane aviation gasoline, the equipment is modifiable to handle a wide variety of organic combustions within the temperature limit of 540°C. (1000°F.).

Briefly, the equipment comprises: (1) Oxygen purification system for combustion gases; (2) oxygen pressure regulating column; (3) electrically heated furnace 24 in. long, with four combustion tubes 1 in. dia. by 30 in. long. Heating intensity for each half of each tube is independently controlled, and temperature of any tube can be readily observed by means of an indicating pyrometer; and (4) conventional absorption trains with calcium chloride for absorption of moisture and Ascarite for removal of carbon dioxide.

The assembly illustrated is merely representative of other multiple assemblies, which can be built up to suit the job involved.

Face Shield

A NEW transparent face shield that may be attached to any protective hat has been introduced by B. F. McDonald Company, Los Angeles manufacturer of safety equipment. Known as the Any-Hat Face Shield, the device is available either in clear or in non-glare amber plastocele.

Its two-piece construction consists of a visor and a frame assembly. The frame assembly clips on the brim of the safety hat, where it remains out of the way and scarcely visible. The visor snaps on this band by means of three snap fasteners whenever face or eye protection is desired and is easily removed when this feature is unnecessary.

The face shield fits all McDonald hats as well as other makes. A bulletin may be obtained by writing the B. F. McDonald Company, 1252-E South Hope Street, Los Angeles 15, Calif.

KEEPING CADENCE WITH WARTIME OIL DEMANDS

The hum of big motors on the Big-Inch Pipe Line... and the zing of electric pumps operating in high octane refineries... and the rhythm of electrically driven units in the oil field and gigantic synthetic rubber plants... these remind you of the fast cadence attained by *Utility Electric Power* today. Each time oil requirements are increased the Utility Electric Power industry also has quickened its cadence to keep abreast the changing trend. Thus, in war or peace, *Utility Electric Power* is geared to the tempo of each new day. It's your most valuable modern servant. So safeguard your motors and electrical equipment. Conserve wherever possible. Help us keep cadence with increasing wartime demands.

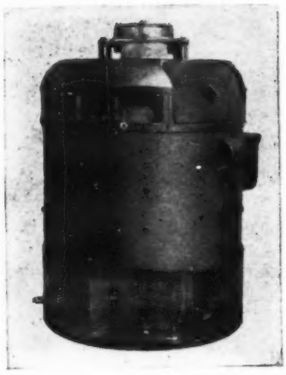
Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

Box 1498, Oklahoma City, Oklahoma

D-C. Vertical Motors

A NEW line of d-c. vertical motors ranging from 40 to 200 hp. at 1750 r.p.m., and in equivalent ratings at other speeds, has been announced by the General Electric Company, Schenectady, New York. The new motors, which are supplied both for constant and adjustable speeds, are designed for low-thrust, solid-shaft applications on pumps, machine tools, and marine underdeck auxiliaries. They are also desirable in cases where valuable floor space must be saved or the expense of gearing avoided.



The motors are of drip-proof, protected construction, providing complete protection from dripping liquids and falling objects. Convenient fittings on both the upper and lower bearings simplify lubrication, and provision for the escape of excessive grease reduces the possibility of over-lubrication. A special bearing housing prevents grease from entering the motor and damaging the commutator and the windings.

The cast-iron conduit box is roomy and can be arranged for bringing the leads in at the top, bottom, or either side. Two hand-hole covers, removable without the use of tools, permit quick and easy inspection of the commutator end brushes. The ring-type base has an accurately machined rabbet and jig-drilled mounting holes, thus assuring permanent alignment with the driven machine. Sturdy lifting lugs facilitate installation.

RUBBER PRODUCTS

AVAILABLE IN STOCK

V-BELTS

MULTIPLE DRIVE BELTS — MATCHED SETS

PARTIAL LIST OF SIZES

Belt Sizes A WIDTH	Belt Sizes B WIDTH	Belt Sizes C WIDTH	Belt Sizes D WIDTH
A-26	B-42	C-51	D-120
A-31	B-46	C-60	D-128
A-35	B-51	C-68	D-144
A-38	B-55	C-75	D-158
A-42	B-60	C-81	D-162
A-46	B-68	C-85	D-173
A-51	B-75	C-90	D-180
A-60	B-81	C-96	D-195
A-68	B-85	C-105	D-210
A-75	B-90	C-112	D-240
A-80	B-97	C-120	D-270
A-85	B-105	C-128	D-300
A-90	B-112	C-144	D-330
A-96	B-120	C-158	D-360
A-105	B-128	C-162	E WIDTH
A-112	B-144	C-173	E-180
A-120	B-158	C-180	E-195
A-128	B-173	C-195	E-210
	B-180	C-210	E-240
	B-195	C-240	E-270
	B-210	C-270	E-300
	B-240	C-300	E-330
	B-270	C-330	E-360
	B-300	C-360	

IMMEDIATE DELIVERY

RUBBER BELTING

HEAVY DUTY — SILVER DUCK — SQUARE EDGE

A.P.I. SPECIFICATIONS

Furnished in All Required Lengths

Width Ply	Width Ply
8" x 6	14" x 6
10" x 6	16" x 6
12" x 6	18" x 6

(Other Sizes Available)

RUBBER HOSE

All Types and Sizes for Use on

LOADING RACK, OXY-ACETYLENE WELDING, COMPRESSORS, STEAM, OIL, SUCTION, WATER, FIRE, PAINT, ETC.

FORMATION TESTER PACKER ELEMENTS

see page 576 Composite Catalogue

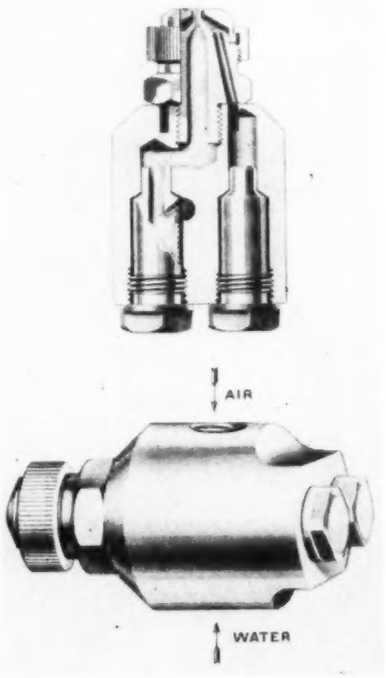
Furnish Details of Your Requirements . . . Prompt Quotations . . . Immediate Deliveries

CARLYLE RUBBER CO., INC.

62-64 PARK PLACE • NEW YORK 7, N. Y.

Atomizing Nozzle

For use in the many modern processes requiring close control of atmospheric conditions, Spraying Systems Company, Chicago, Illinois, has developed an improved type of pneumatic atomizing nozzle. In this nozzle, the



Type JHS, water and compressed air are mixed externally to produce a round spray. This spray is projected 10 to 20 ft. depending on air pressure used in the humidifying system.

Because this new nozzle is a complete unit in itself, it can be quickly and easily adapted to almost all types of installa-

tions, it is stated. In the Type JHS, two monel metal strainers—one for air, the other for water—are included right in the body of the nozzle. This permits easy removal of the strainers for cleaning or replacement without disturbing the nozzle or lines. It eliminates every possibility of clogging the nozzle orifice by pipe scale or other dirt.

Every detail of the nozzle's construction contributes to simplified maintenance, lower operating costs, and improved atomization, it is pointed out.

30-Shot Gun Perforator

McCULLOUGH TOOL COMPANY, Los Angeles, California, and Houston, Texas, is now operating a gun perforator that produces six perforations per ft., or 30 perforations in a 5-ft. section. The perforations are in four staggered rows 90° apart. When a zone of considerable thickness is to be perforated, several guns are joined together to perforate a section of 10, 15, or 20 ft. on each run. The spacing of the perforations is the same when the multiple guns are used. When more than six holes per ft. are desired, the casing is perforated a second time, the gun being positioned an inch higher or lower than the first time. Thus, four additional staggered rows of holes are obtained, giving 12 holes per ft.

Due to the fact that all shots are fired simultaneously while the gun perforator is at rest, the spacing of the perforations is exact and uniform, being a projection of the position of the barrels in the gun perforator.

The 3½-in. O. D. gun fires ¼, ⅜, ½, and ⅝-in. bullets. The 4¼-in. O. D. gun fires ¼, ⅜, ½, ⅝, and ¾-in. bullets.

As in the case of all other McCullough gun perforators, the 30-shot guns are fired either electrically or mechanically when run on wire line. McCullough completely equipped service units, operating from 16 service branches in active domestic areas, carry the required conductor cable, line-measuring device of proved accuracy, and all other equipment. This gun perforator can also be run on drill pipe or tubing, either singly or in multiple, and is fired mechanically by means of a go-devil dropped inside the pipe or operated on a measuring line. This latter method permits the utilization of careful measurements of the pipe in positioning the gun perforator at the exact point designated in the hole.

Amercoat No. 33

AN additional development in thermoplastic coatings just announced is the compound called Amercoat No. 33, for application on metal, concrete, or wood. This product is a liquid plastic that is cold-applied by conventional spray or brush methods. It has a distinct practical advantage in that it may be applied in any number of coats required for any particular condition or use.

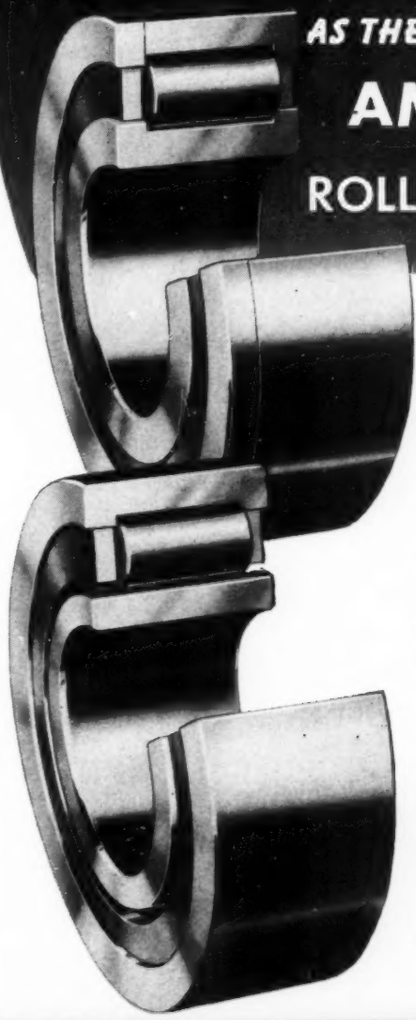
Amercoat No. 33 is a combination of the most inert synthetic resins obtainable and is the result of two years' development and test both in the laboratory and in the field. According to the manufacturer, it has shown excellent performance in such applications as: lining for storage tanks and other equipment to protect foods from contamination by corrosion caused by dilute acids or caustics; for super-structures, deck machinery, ventilators, and other marine equipment; for concrete urinals, shower bases, and laundry trays in defense housing, Army, Navy and air bases, shipyards, factories, etc.

Full details on Amercoat No. 33 are contained in a new bulletin just issued. Write American Pipe and Construction Company, P. O. Box 3428, Terminal Annex, Los Angeles, California.

DEPENDABLE

AS THE NAME THEY BEAR

AMERICAN
RADIAL
ROLLER BEARINGS



Engineered specifically for extra heavy duty applications where the load is *radial,* AMERICAN RADIAL ROLLER BEARINGS function smoothly and dependably under the most exacting service conditions. Specialized construction, flawless materials and precision manufacturing, set them apart as *the most dependable bearing yet designed* for radial loads where strains are greater . . . where toughness, super-strength and smooth, continuous, trouble-free performance are absolute requisites.

AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Write for complete data or send us your requirements for analysis and recommendations.

American Roller Bearing Co.
Pittsburgh, Pa.

Pacific Coast Office:
1718 S. Flower Street
Los Angeles, Calif.

AMERICAN
ROLLER BEARINGS
HEAVY DUTY

AMERICAN
Heavy-Duty ROLLER BEARINGS

BLOCK SELECTIONS from the McKISSICK CATALOGUE

LOGGING or LOADING BLOCK

Designed for heavy duty service. This block has heavy cast steel sheaves with line groove 1½" maximum. The large center pin is shouldered to prevent housings from pinching or spreading under heavy loads. Equipped with high speed bronze bushings or Hi Load roller bearings, and Alemite lubrication. Steel clevis with 1" diameter alloy clevis pins.

★ *Buy* MORE WAR BONDS

PEERLESS SNATCH BLOCK

This is an improved snatch block in the lower priced field. It is quick-opening, flexible and sturdy. It is safely locked and quickly released by improved locking pin. The yoke permits hook to swing as well as swivel, thereby relieving undue strain and affording greater flexibility. It is also available with swivel clevis.

ALLSTEEL HEAVY DUTY SNATCH BLOCK

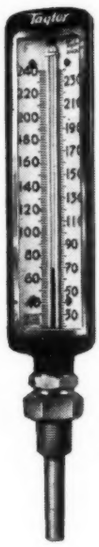
This block was designed for all kinds of heavy trucking, tractor and rotary work. It is so constructed that it will not spread under heavy loads and is available with single, double, or triple sheaves. Swivel hook swings to one side to permit insertion of line. It is furnished in 12" x 6", 15" x 8" and 16" x 10" sizes. Steel swivel hooks or closed clevis are interchangeable.

Catalog on Request

McKISSICK PRODUCTS CORPORATION
TULSA, OKLAHOMA

One-Piece Thermometer

MOTIVATED by a desire to save critical metals in war time, Taylor Instrument Companies, Rochester, New York, have designed, tested in the field, and are now introducing a one-piece industrial thermometer.



The one-piece case is shallower, which makes it possible to see the mercury column through a wider angle of vision. The chromium-plated bezel fits snugly into the grooved case in such a way as to hold the thick glass front securely against four wavy tension springs. These springs are fastened securely under the scale by shakeproof screws. This construction results in a dustproof, rattleproof, and practically fumeproof thermometer. It can withstand vibration and severe shocks.

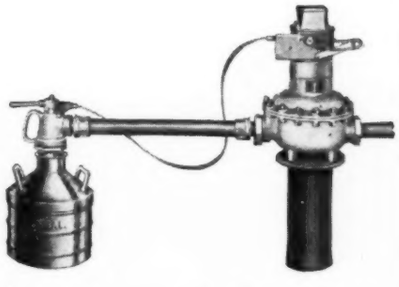
These improvements combined with permanent accuracy, responsiveness to change in temperature, and durability, plus a saving of tons of critical bronze, make the new instrument of great interest to industrial thermometer users.

The company has announced further that the new instruments will be equipped with easy-reading Binoc tubing. They will be supplied in many combinations of straight and angle stems, with threaded or union connections, and in many standard temperature ranges, within the limits of minus 40°F. to plus 750°F. Standard scale lengths are 7 in. and 9 in. Numerals are bold and clear, standing out sharply against a contrasting background.

Write to the company for Bulletin No. 98030.

Small Model Drum Filler

INCREASING demand for small containers of petroleum products, largely brought about by military needs, has prompted the National Meter Division of the Pittsburgh Equitable Meter Company to bring out a smaller unit of its Empire Drum Filler, designated as Model "B". The manufacturer recommends its use in filling containers ranging from 5 to 30 gal. in capacity.



This unit utilizes a 1½-in. Empire Oscillating Piston Meter as the measuring medium. It is fitted with a temperature compensator that automatically corrects to deliver a volume the exact equivalent of the desired volume at 60° F. It is stated that no manual attention is required as the compensation is done automatically during delivery with every change of temperature as it occurs.

The Empire Model "B" Drum Filler has the same control apparatus as is used on the larger Model "A" unit. This consists of a repeat type register on which is externally mounted a quantity chain having a fixed cam thereon to trip a mechanically operated control valve. Six chains are normally supplied with each drum filler, in lengths to meet specified delivery cycles desired.

The manufacturer states that with the Empire Model "B" Drum Filler, a 5-gal. can of gasoline can be accurately filled in 15 sec.

For additional information write the Pittsburgh Equitable Meter Company, Pittsburgh 8, Pennsylvania.

8 Good Tips

on how to make brake lining last longer...

1. TRUE UP SCORED RIMS
before applying brake lining.

2. BE SURE WATER IS ON WATER-COOLED RIMS
before starting to run in drill pipe.

3. HAVE BRAKES EQUALIZED AT ALL TIMES

4. WHEN RELINING BANDS
be sure that brake bands are not out of round or kinked.

5. STONE OR SMOOTH UP
badly checked rims before applying lining.

6. REVERSE BANDS,
if live and anchored ends are interchangeable, when anchored end is half worn. This increases life more than 40%.

7. USE LINING IN SEGMENTAL FORM
Such action simplifies application, allows for release of worn particles and permits greater heat dissipation.

8. DO NOT USE OIL, CLAY
or other foreign materials to control friction. This causes gummed brake surfaces, early replacement of lining.

• And be sure you start rigs off right... by using J-M 420 Rotary Lining. Tough, durable, easy to wear in, J-M 420 assures even feed-off, easy load control, high braking efficiency. For details, write for brochure FM-10A. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

Johns-Manville 420 ROTARY LINING

Automatic Stop Valve

THE new Grove Automatic Stop Valve is designed for use on air or gas pressure lines, where there is any possible danger of fractures or leakage resulting in pressure loss or damage. It automatically shuts off the flow when the pressure falls to a preset point. It must then be manually reset before the flow is permitted to be resumed. In its operation it utilizes the same basic principle of Grove Powreactor Dome Pressure Reducing Regulators. A few of the many applications on which this valve is employed include: Air supply lines for gas ejection on large guns, where a line fracture could cause loss of pressure in the entire system; lines carrying gas at high pressures, where a large volume of escaping gas might create a fire or explosion hazard in addition to losing required system pressure; gas lines carrying fuel to boilers, ovens, furnaces, etc., where explosions could result from momentary interruption of delivery, followed by the uncontrolled return of fluid supply. It can be operated on rate of flow differential pressure or on direct static line pressure. In its extremely wide rangeability, a 300-lb. valve may be set to operate at any pressure from 5 lb. to 300 lb. The stop point is established by merely presetting the desired shut-off pressure in the dome.

Full details may be obtained by writing Grove Regulator Company, 65th and Green Street, Oakland 8, California, asking for Bulletin No. 515.

"Rotamatic" Controller

WITH the rotameter, which consists essentially of a tapered pyrex glass tube within which a metering float moves up and down, highly accurate flow rate readings may be obtained, even with viscous or highly corrosive fluids, according to the manufacturer, Fischer and Porter. For automatically controlling the flow rate of fluids being measured with rotameters, Fischer and Porter have developed the "Rotamatic" controller. The "Rotamatic" is connected to the rotameter through a self-operated induction bridge system and operates a pneumatic system that positions the air motor of a diaphragm valve. The "Rotamatic" is equipped with automatic reset and full throttling range for adjustment to the most complicated flow control problem. Remote Reading Recorders or indicators are supplied as desired with the "Rotamatic." Now it is possible to combine "automatic flow control" with all the other advantages possessed by the rotameter, such as wide flow range, visibility or metering elements, low pressure loss, and linear calibration scale, it is asserted.

Bulletin 51-B, containing complete information, is obtainable by writing to Fischer and Porter Company, 899 County Line Road, Hatboro, Pennsylvania.

Pulsation Dampener

THE Ashcroft Gauge Division of Manning, Maxwell and Moore, Inc., Bridgeport, Connecticut, announce its new Type 1106 Ashcroft Pulsation Dampener, a small, compact throttling device, for use with pressure gauges subject to severe pressure pulsations and rapid fluctuations, such as on reciprocating pumps.

The equipment is good for all pressures up to 5000 lb. per sq. in. and for any pressure medium such as air, water, oil, or steam, whenever a dampening device is needed, it is stated. Excessive or harmful pointer vibration is eliminated and wear on the gauge movement is avoided. Time is saved in reading the true mean pressure, the manufacturer states. The dampener helps keep the gauge in calibration and prolongs gauge life.

Save Up to 80%

On Pump Repairs and Pulling Expense

Use Long-Life MARTIN PLUNGER

With Replaceable Packing Rings

3¾" x 36 Groove Martin Plunger Body Without Rings.

These Martin rings take all the wear, and one set will far outlast any other type of wearing surface. The Martin plunger body, being smaller than the barrel, is therefore not subject to wear and can be used over and over indefinitely. Changing Martin rings is as easy and simple as changing the blade in your safety razor.

Tube life is generally increased two to five times. The grinding action of sandy fluid is greatly reduced because of the resilience of the Martin Rubber and fabric rings. Furthermore, there is no lack of lubrication even when pumping 100% salt water. Water lubricates rubber.

Conserve with MARTIN PLUNGERS

Only MARTIN PLUNGERS have the One-Piece "Fluid Proof" Bodies and "compensated" precision packing rings.

Write for Illustrated Catalog or see Composite Catalog, Page 1619

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

FIELD REPRESENTATIVES

Tom Hulett, El Dorado, Arkansas
C. J. Baeten, Wichita, Kansas
Lynn C. Holloway, Houston, Texas
Hugh Robinson, Blackwell, Oklahoma
F. M. Wilson, Wichita Falls, Texas
J. Walter Wade, Olney, Illinois
E. C. Dilgarde, Casper, Wyoming

R. M. Cook Appointed Security Sales Manager

Security Engineering Company, Inc., Whittier, California, has announced the recent appointment of R. M. Cook as sales manager of that company. Cook is well known in the oil industry and brings to the firm an extensive back-

R. M. COOK

ground of oil-field experience, having spent his entire business career in the oil business.

Cook was associated with Byron Jackson for 11 years as sales manager and was active in conjunction with that firm in organizing the Pacific Cementing Company, now known as International Cementers, Inc., in which he performed the duties of vice-president and general manager. He later became associated with McCullough Tool Company in the capacity of sales manager.

For the last 15 years Cook has been active in Mid-Continent and Rocky Mountain areas, traveling in Wyoming, Montana, Arizona, Colorado, Kansas, New Mexico, Texas, Louisiana, and Arkansas, as well as California, and is well acquainted with the various drilling and producing problems in these areas. He will cover this same territory in the interests of Security Engineering Company, Inc.

Duraloy Names Agents

The Duraloy Company of Scottdale, Pennsylvania, producers of static and centrifugal high alloy castings, announces the appointment of Robert Onan as its sales representative in the Chicago area and Kilsby and Graham as its agents in the California area.

Onan will have his office in the Wrigley Building, Chicago, and will operate as The Duraloy Company of Chicago.

Kilsby and Graham are in the Standard Oil Building, Los Angeles, Calif.

Cooper-Bessemer Awarded Gold Star

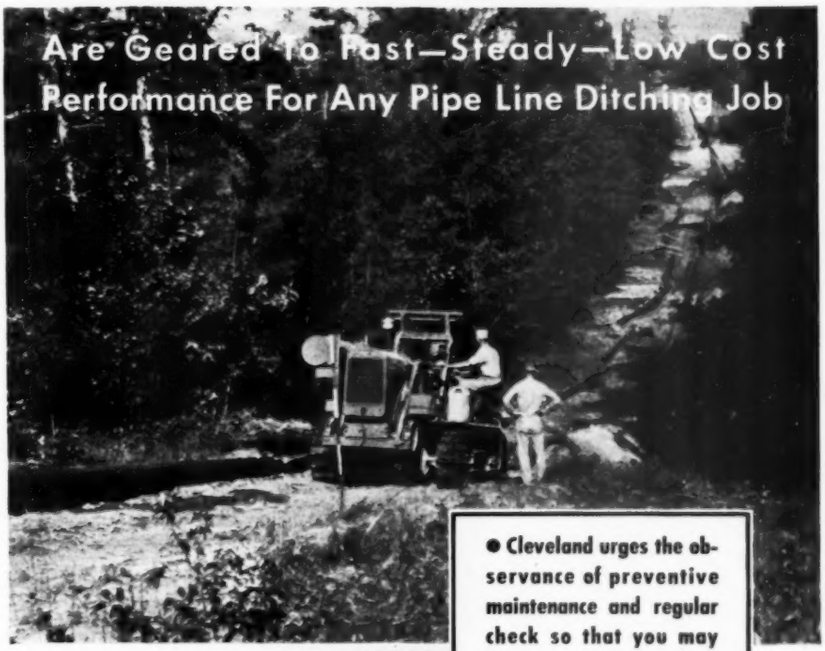
Further recognition of the production record maintained by The Cooper-Bessemer Corporation since it received the Maritime "M" award several months ago, has been announced. The company has now added the first gold star to the Maritime "M" pennants displayed at its Mount Vernon, Ohio, and Grove City, Pennsylvania, plants.

In commenting on this added token for meritorious war production, Gordon Lefebvre, Cooper-Bessemer's president and general manager, made the following statement:

"Despite the increasing hardships induced by shortages in manpower and materials," said Lefebvre, "our anticipated production volume for 1943, based on actual output since the first of the year, will approximate a 27 percent increase over 1942. With the inspiration of this new honor just bestowed upon us by the U. S. Maritime Commission, Cooper-Bessemer workers are already making every effort to increase their efficiency and individual efforts."

"CLEVELANDS"

Are Geared to Fast—Steady—Low Cost Performance For Any Pipe Line Ditching Job



• Cleveland urges the observance of preventive maintenance and regular check so that you may keep your ditching machines in top condition to deliver constantly maximum performance.

• Speed, flexibility, ease of operation, coupled with their correct compact design and sturdy long-life construction are some of the reasons why CLEVELANDS deliver "Top" performance at minimum cost day in and day out.

Main Line—Field Line Ditching . . . Stripping for Take-up and Reconditioning . . . CLEVELANDS take them all in stride.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE. "Pioneers of the Small Trencher" CLEVELAND, OHIO
"CLEVELANDS" Save More . . . Because they Do More

A.G.A. Plans for Important Meeting

How can the gas industry more effectively serve the nation at war?

In what additional ways can the constructive use of gas be encouraged to conserve fuel, to supply war industry, and to support essential civilian morale?

Are there any further means of adjusting the remaining available manpower or utilizing new sources so as to reach the greatest industry efficiency?

What more can be done to increase, preserve, and conserve the food supply of our armed forces and our civilian population?

What can the industry do without diverting energies from the war effort to be ready to meet the changed demands and opportunities to contribute to the general welfare during the post-war period?

These and other questions of similar import are to be asked and answered at the Twenty-fifth Annual Meeting of the American Gas Association in St. Louis, Missouri, October 11, 12, and 13.

Commemorating the Silver Anniversary of the founding of the American Gas Association, a special ceremony is tentatively planned for the meeting. Organized in June, 1918, to meet the problems of the first World War, it is noteworthy that the Association today faces the same problems on a magnified scale that it did 25 years ago.

Although the program is not completed and must be governed somewhat by last minute events, it is now expected that there will be two general luncheons with addresses on wartime regulations and on wartime personnel problems. These will be held Tuesday, October 12, and Wednesday, October 13. The first general session will follow the Tuesday luncheon and additional general sessions will take place Wednesday morning and afternoon. The Home Service Breakfast will be held Wednesday. In keeping with the times, no entertainment functions are planned.

Arthur F. Bridge, president of the Association and vice-president and general manager of the Southern Counties Gas Company, Los Angeles, will preside at the general sessions. Ernest R. Acker, chairman of the Committee on War Activities and presidential nominee, and other notable gas industry men are expected to take a prominent part in the proceedings.

Awards for distinguished service to the gas industry will be a highlight of the meeting. These include the Charles A. Munroe Award, the Beal Medal, the A.G.A. Meritorious Service Medal, the McCall Awards, and the Million-Man-Hour Awards for accident prevention.

A meeting of the Natural Gas Section will be held Monday morning, October 11. Meetings of the Accounting, Industrial and Commercial Gas, Residential, and Technical Sections will take place on Monday afternoon and Tuesday morning. Also a number of committees will conserve time and travel by taking advantage of the presence of the delegates to attend committee meetings.

Although all meetings will be held at the Hotel Jefferson, nearby hotels will be available to the gas industry delegates.

Under the direction of Burt R. Bay, chairman of the Natural Gas Section and president of the Northern Natural Gas Company, Omaha, a program of timely interest and value is rapidly taking shape for that body. Representatives of industry and government will speak on the most urgent problems and a new slate of officers will be elected. A special feature of this meeting will be the presentation of honorary memberships to pioneer natural gas men.

Industrial and commercial gas men, equipment manufacturers, and others interested in non-residential gas and appliances will meet Monday at the Industrial and Commercial Gas Luncheon. The luncheon will be followed by a business and technical session that will take the entire afternoon. This part of

In the heaviest, most powerful machinery built . . .under terrific strains and impacts . . . where going is tough, punishment brutal and service continuous . . . there you will find AMERICAN SUPER HEAVY DUTY BEARINGS doing their job quietly, smoothly and efficiently.

AMERICAN SUPER HEAVY DUTY BEARINGS are designed especially for strenuous, gruelling, around-the-clock service. Their simple construction, absolute precision and tremendous strength, assure longer, safer, lower-cost, trouble-free performance under the most adverse service conditions.

Consult our engineering department for full technical details. Write TODAY!

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PITTSBURGH PENNSYLVANIA
Pacific Coast Office: 1718 South Flower Street, Los Angeles, Calif.

AMERICAN ROLLER BEARINGS HEAVY DUTY

AMERICAN
Heavy-Duty ROLLER BEARINGS

the meeting will be in charge of Chairman Ben H. Gardner of Columbus, Ohio, and Vice-Chairman Charles G. Young, of Springfield, Massachusetts. The program was prepared by a committee headed by Franklin T. Rainey, sales promotion manager of The Ohio Fuel Gas Company.

Officers of the Technical Section have keyed their program to war developments. Two sessions will be held, the first, Monday afternoon, and the second, Tuesday morning.

Harold L. Gaidry, of New Orleans Public Service, Inc., chairman, will open the meeting with a review of the Section's activities during the year. The latest advances in gas production, distribution, and chemistry including the work of important committees, will be covered by able speakers. Reports on research projects such as mixed gas, organic sulphur, and water gas will be made at this time.

Among the topics tentatively arranged for presentation are: "High Temperature Gasification," "Storage of Oil," and "Motor Vehicles and Emergency Conditions." It is also expected to have a symposium on post-war planning with Charles F. Turner, vice-chairman, Technical Section, presiding.

Of particular interest to distribution men will be a symposium on distribution studies embracing such subjects as "Tin in Solder," "Microbiological Anaerobic Corrosion," and "Dissimilar Metals." This symposium will be led by H. B. Andersen, chairman of the Distribution Committee.

Seiler a Vice-President Of Tube Turns

John G. Seiler has been elected vice-president of Tube Turns, Louisville, Kentucky, manufacturers of

JOHN G. SEILER

Tube-Turn welding fittings and flanges. Seiler will retain his duties as sales manager of the company.

Cable to Pittsburgh For Lincoln Electric

Announcement has been made of the appointment of H. E. Cable, welding engineer of The Lincoln Electric Company, Cleveland, Ohio, as representative in the Pittsburgh territory. Cable will assist W. R. Parsons, Pittsburgh district manager of the company.

A graduate of Case School of Applied Science, where he majored in mechanical engineering, Cable became affiliated with Horsbaugh and Scott Company. Later he formed a partnership with a former associate with sales agencies for the distribution of water-treating equipment. He joined the National Aluminate Corporation of Chicago in 1933.

Prior to joining The Lincoln Electric Company, Cable was general manager of Aluminate Chemicals, Ltd., of Toronto, a subsidiary of National Aluminate Corporation.

Cable is a member of the American Society of Mechanical Engineers, American Chemical Society, American Water Works Association, Master Boiler Makers Association, and is a professional engineer of the State of Ohio.

• • • WHEN
HILL—HUBBELL
STEEL PIPE PROTECTION WILL BE IN GREATER DEMAND

When that time comes, our then realized plans will meet that demand with improved techniques.

Meantime, those whose underground steel pipe is being conserved with HILL-HUBBELL work have the security that goes with sound investment.

HILL-HUBBELL Steel Pipe Protection is applied at these leading mills.

- Jones & Laughlin Steel Corporation
- National Tube Co.
- Spang Chalfant, Inc.

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE: SAN FRANCISCO, CALIFORNIA, U. S. A. •

HIGHER CUTTING EFFICIENCY from SEISMOGRAPH BITS

Hard-Facing Recommendations For Obtaining More Footage—Faster Cutting—Less Down-Time For Bit Resharpening

1. Always include at least one Borium insert at the lower, outside corner of each cutting wing to prevent "diamond pointing." (Sketch)

2. On bits larger than 6 inches O.D a second Borium insert on the lower cutting edge improves drilling efficiency. (Sketch)

3. Cover leading faces of all bit wings with Tube Borium, using screen size of at least 10-20 mesh rather than finer meshes such as 30-40. Tests conclusively prove the larger Borium particles greatly increase drilling speeds.

4. Don't skimp on quantity. Tests show that bit life and efficiency is in direct proportion to the amount of Tube Borium applied (up to ⅛" in thickness).

More Seismograph Bits Are Hard-Faced With Tube Borium Than Any Other Alloy

STOODY COMPANY

1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear . . . Eliminate Repair

Second Army-Navy "E" Award to Macwhyte

The second Army-Navy "E" award has been made to Macwhyte Wire Rope Company, Kenosha, Wisconsin, in recognition of "continued and determined effort and patriotism." The award covers the period from the date of the first award (in the case of Macwhyte Wire Rope Company, November 21, 1942) until the time of the second award (in this case August 21, 1943).

The second award consists of an Army-Navy "E" Flag similar to the first one but with the addition of one white star in the red field.

Collins Rejoins Cummins

On leave of absence for the last year in performance of a special assignment for one of the country's largest motor freight lines, Tom Collins has rejoined the Cummins Engine Company, manufacturers of Cummins Diesels, in his former capacity of manager of the company's Pacific Southern Region.

TOM COLLINS

Announcement of Collins' return, welcome news to his host of friends among west coast Diesel operators, was made by P. E. Letsinger, vice president in charge of distribution, at Columbus, Indiana, site of the company's factory and general offices. According to this announcement, Collins will make his headquarters at the new regional offices, which have been established at 411 West Fifth Street, Los Angeles.

Collins is a veteran member of the Cummins sales organization. He first became connected with the company, several years ago, as a sales representative of the Cummins dealer in Seattle. His work here later led to his appointment as manager of the Central Region, with offices in Cleveland, Ohio. From Cleveland he was transferred to the west coast as manager of the Pacific Southern Region, with headquarters then in Phoenix.

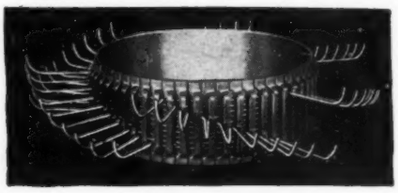
Approximately one year ago, Collins temporarily left the company to undertake a special project for Pacific Freight Lines, whose fleet of Cummins Diesel-powered trucks constitute one of the nation's most extensive highway transport systems. Here, by virtue of his long experience in this field, Collins was able to perform valuable service to Pacific Freight Lines in his role of executive assistant to President G. M. Duntley.

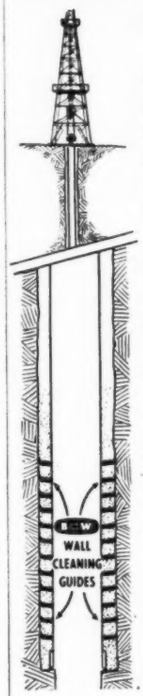
Prevent CRATERING

by using . . . B and W, Inc.

WALL CLEANING GUIDES

on your SURFACE CASING





1 TO PREVENT BLOW-OUTS

Wall Cleaning Guides placed on the bottom joints of surface casing protect against blow-outs around the casing, or cratering from an imperfect cement job.

2 TO PREVENT BACKING OFF

The rotation and jarring of the drill pipe tends to loosen the threads of the bottom joint of surface casing, particularly opposite an imperfect cement job. The unscrewing of this joint may result in an impossible fishing job, or abandonment.

Wall Cleaning Guides placed on the bottom joints will assist in securing a *perfect* cement job, which in turn will securely anchor the casing to the formation.

Table of Dimensions

Casing Size	Hole Diameter	Outside Wire Diam.
8⅝"	12¼"	14½"
9⅝"	12¼"	14½"
10¾"	14¾"	16¾"
13⅜"	17¼"	18½"

BRUCE BARKIS — B and W, Inc. — KENNETH WRIGHT
Well Completion Specialists

WEST COAST
3545 CEDAR AVENUE
LONG BEACH, CALIFORNIA
TELEPHONE: LONG BEACH 4-8366

GULF COAST
305 M. AND M. BUILDING
HOUSTON, TEXAS
TELEPHONE: PRESTON 9783

W. H. Cox Transferred

W. H. COX

Walter H. Cox, who for the last four years has been sales representative for Lee C. Moore and Company, Inc., with headquarters at Evansville, Indiana, has been transferred to the company's home office in Pittsburgh, Pennsylvania, where he will have charge of their oil field sales in the states of Pennsylvania, New York, West Virginia, Ohio, and Michigan.

Keuffel and Esser Fly 4-Star Pennant

Keuffel and Esser, Hoboken, New Jersey, manufacturers of drafting and engineering equipment for more than three quarters of a century, has been awarded the 4-star Army and Navy "E", it has been announced.

This latest award to Keuffel and Esser, and its more than 2000 employees, is the fifth they have received from the Army and Navy as a credit to their 2½ years of sustained excellence in the production of precision instruments for the U. S. armed forces.

With this award, Keuffel and Esser is now one of a very small group of manufacturers whose standards of production entitle them to fly the 4-star pennant as a symbol of war-time service.

Luli Assumes New Duties

Willard A. Luli, engineer with The Cooper-Bessemer Corporation for the last eight years, has been promoted to the post of factory production representative for the two plants of the company located at Mt. Vernon, Ohio and Grove City, Pennsylvania.

W. A. LULI

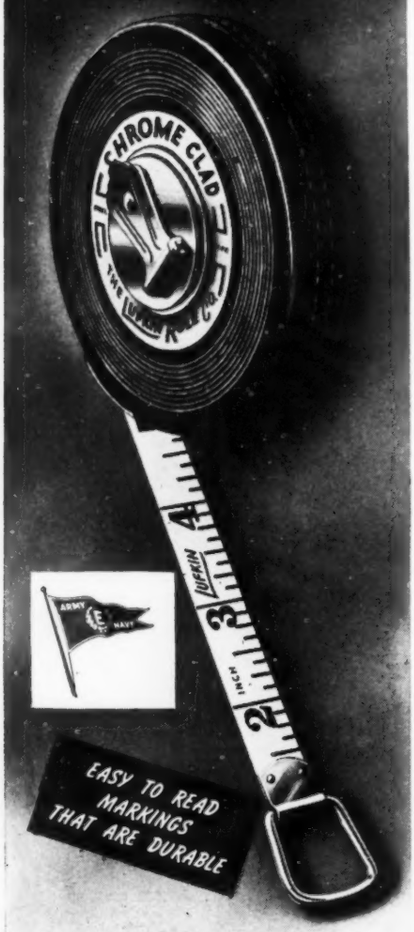
In his new assignment, Luli is affiliated with the company's Washington, D. C., office where he serves as Cooper-Bessemer representative on the War Production Board for the Large Diesel Engine Manufacturers' Planning and Scheduling Committee.

Luli's principal duties involve the allocation of materials needed by Cooper-Bessemer for all-out war production.

Cold Coffee...
The HIGHER STANDARD
A dining-car passenger was served cold coffee. He complained. The waiter, as he returned to the kitchen for a cup of hot coffee, grumbled . . . "That man doesn't even know there's a war on!"
Sure there's a war on. Staffs are short, materials more so. New taxes, limitations and regulations to worry about. But that's no excuse for carelessness or short-sightedness.
Winning the war is our first duty. Winning the peace is the second. On either job — you'll get no cold coffee from Spang!
SPANG & COMPANY . . . Butler, Pa.
The Bigge
TOOLS

LUFKIN

"ANCHOR" CHROME CLAD STEEL TAPE — THE OILMAN'S CHOICE



ONE HALF INCH LINE

A sturdy, finely-built tape that every busy oilman will want to carry. Jet black markings on the satin chrome finish are easy to read—even in poor light. Surface won't rust, crack, chip or peel. Genuine leather case. Folding flush handle is opened by a push pin. See the "Anchor" at your supply house and write for catalog.

LUFKIN

SAGINAW, MICHIGAN • New York City

TAPES · RULES · PRECISION TOOLS

S.C.I. Presidential Dinner October 22

Foster D. Snell, chairman of the American Section of the Society of Chemical Industry, announces the following committees for the presidential dinner to be held on October 22 at the Waldorf-Astoria for Wallace P. Cohoe, newly elected president of the S. C. I., an organization of international scope.

The Honorary Dinner Committee, consisting of Marston T. Bogert, Thomas Midgley, Charles L. Parsons, and Maximilian Toch, will have James Bryant Conant, president of Harvard University, as chairman.

On the Publicity Committee with Walter Murphy, editor of *Industrial and Engineering Chemistry* as chairman, D. D. Berolzheimer, F. J. Curtis, Gustav Egloff, S. D. Kirkpatrick, J. L. K. Snyder, R. L. Taylor, and E. C. Williams will serve.

Walter S. Landis, vice president of American Cyanamid Company, heads the Speakers Committee assisted by Lawrence W. Bass, W. A. Gibbons, H. D. Smith, G. M. A. Stine, and A. J. Weith.

Walter J. Baeza is chairman of the Dinner Committee, which consists of E. R. Allen, Robert Calvert, Ralph Evans, Robert Heggie, J. W. H. Randall, and W. D. Turner.

The Ways and Means Committee, with S. D. Kirkpatrick, editor of *Chemical and Metallurgical Engineering*, as chairman, is supported by G. DuBois, J. V. N. Dorr, C. R. Downs, W. W. Duecker, C. N. Frey, R. E. Gage, R. E. Gruber, D. B. Mason, J. G. Vail, L. W. Waters, W. B. Weigand, and L. T. Work.

Dinner reservations will be handled by J. W. H. Randall, 50 East 41st Street, New York.

Oil Movie Released

A new U. S. Bureau of Mines educational motion picture entitled "Petroleum and Its Uses," has just been released for free distribution, it is announced by Dr. R. R. Sayers, director of the bureau. The film depicts the important role played by petroleum and its products in the daily life of the average American family. It is in 16 mm. sound with a running time of 42 min. Pictured also are scenes from the laying of the "Big Inch" pipe line, modern oil well drilling, and many other views that pertain to the industry or the use of its products.

C.N.G.A. Annual Directors Meeting

Annual directors' meeting California Natural Gasoline Association, Los Angeles, July 20, 1943: Standing, left to right: Randal Maass, General Petroleum Corporation, chairman, fall meeting committee; M. L. Arnold, Richfield Oil Corporation; John C. Herron, Shell Oil Company, Inc.; W. L. Rifenberick, Industrial Engineers, Inc.; J. B. Taylor, Signal Oil and Gas Company; D. A. Cushman, O. C. Field Gasoline Corporation; R. S. Tulin, Shell Oil Company, Inc.; J. C. Gilbert, Barnsdall Oil Company; J. A. Campbell, J. A. Campbell Company; W. A. Kirk, California Southern Oil Company; H. W. Parmelee, Del Valle Gasoline Company; R. C. Wheeler, General Petroleum Corporation; I. B. Funk, Cowan Oil and Refining Company; O. C. Field, O. C. Field Gasoline Corporation; Harold Saueressig, Southern California Gas Company, chairman, program committee; R. R. Crippen, The Texas Company, chairman, technical committee; W. C. Dayhuff, Standard Oil Company; George L. Tyler, secretary, C.N.G.A. Seated, rear row, left to right: L. W. Wilbern, Daniel Orifice Fitting Company, chairman, membership committee; L. V. Cassaday, Lomita Gasoline Company; G. C. McLaren, director and chairman, finance and budget committee; Warren Kraft, Honolulu Oil Corporation; H. A. Dresser, Fluor Corporation, Ltd., chairman, entertainment committee; Harold Linhoff, Richfield Oil Corporation; R. D. Gibbs, director and chairman, gas report committee. Seated, front row, left to right: P. S. Magruder, General Petroleum Corporation; R. W. Heath, Signal Oil and Gas Company, president, C.N.G.A.; C. D. Gard, Union Oil Company, vice-president, C.N.G.A.; John Rogers, Cooper-Bessemer Corporation.

Miller General Shop Supt. for Lane-Wells

E. A. (Doc) Miller has been appointed general shop superintendent of Lane-Wells Company, according to an announcement made recently by Rodney S. Durkee, president. He will have charge of manufacturing operations in

E. A. (DOC) MILLER

the Los Angeles plant, which has been enlarged to manufacture war material in addition to their regular oil well tools and specialized service equipment.

Miller comes to his new post with a broad background of experience with leading oil companies and oil well equipment manufacturers.

Born in Louisiana, Miller first went to work for Magnolia Petroleum Company where he served his apprenticeship as a machinist. He moved to California in 1922 and entered the employ of the General Petroleum Company where he became general foreman of their manufacturing and service maintenance shops.

H. G. Schad a Director of Atlantic

H. G. Schad, general manager of transportation of The Atlantic Refining Company, Philadelphia, Pennsylvania, has been elected a member of the board of directors of the company, it is announced. He will fill the vacancy on the board caused by the recent retirement of William Downs Anderson.

Schad joined the company as assistant to the general manager of transportation in 1925, and was made general manager in October, 1941.

Simplicity of Design Means Easier Maintenance

Easy Servicing . . .

A Help for the Maintenance Man

So simple in design, so sturdy in construction, so resultful in lasting-ability is the "King-clip" Valve, only a minimum of maintenance is required to keep it in good working order.

And when service is required, the ease with which the valve can be disassembled for inspection and repairs, is a real time and labor saver. Any maintenance man knows that this provision for quick servicing is a long step toward the uninterrupted production hours he is striving for.

"KING-CLIP" GATE VALVE

A further aid to the attainment of easier and more efficient maintenance is the precision-gauged manufacture of replacement parts, assuring an exact duplicate of any part that may have to be renewed.

A Lunkenheimer distributor is near you to help you get what you need. His complete facilities are at your service.

Here's how easily the "King-clip" valve can be disassembled - - -

Unscrew two nuts at top of clip and entire bonnet-stem-disc assembly can be lifted from the body. Complete accessibility for inspection or repairs is the work of a few minutes. - - - Circular 504 fully describes the "King-clip" valve. Ask for a copy or write us direct.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI 14, OHIO, U. S. A.
NEW YORK CHICAGO
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LUNKENHEIMER VALVES

Delegation of Powers to Paw

The delegation of powers to the Petroleum Administration for War granted by the War Production Board in Directive No. 30 is largely a matter of legal form and not a major policy delegation, Acting Petroleum Administrator Ralph K. Davies has stated:

"The primary purpose of WPB Directive No. 30 is to establish a uniform legal base, independent of delegations hitherto contained only in specific WPB orders, upon which base orders issued by the Petroleum Administrator can rest, whenever these orders enter fields of the scope specifically delegated to the Administrator in Executive Order 9276.

"This Directive was deemed advisable because the previous delegations, which included most of these powers, were incorporated in specific orders of the War Production Board. The uniform legal base established by Directive No. 30 will give PAW more legal flexibility in issuing, amending, or revoking Petroleum Administrative orders, in those fields in which it derives its legal authority from the War Production Board.

"The new WPB Directive does not make any changes in the agreements and working arrangements previously made between PAW and WPB relative to prior clearance with WPB of such Petroleum Administrative Orders. It is largely a matter of legal form and not a major policy delegation."

No Restriction on Illinois Wells

Deputy Petroleum Administrator Ralph K. Davies has emphasized that there is no restriction by the Petroleum Administration for War upon oil production from wells in Illinois.

Commenting on a statement attributed to State Senator Earl B. Searcy of Illinois, Davies said:

"State Senator Searcy is quoted as stating that PAW is restricting wells, capable of producing 150 bbl. a day to 20 bbl. daily. The simple fact is that PAW does not restrict production from any wells.

"Some of the states have regulatory bodies which do restrict production in order that wasteful production this month will not mean a decreased production next month, and a severe loss in the amount of oil ultimately to be recovered from the well before it runs dry. Incidentally, the state authorities have done a good job of this.

"Illinois does not have a conservation body with authority to enforce conservation. That state would be producing much more oil today and would have produced a lot more oil during the period of the war if its fields had not been gutted by wasteful operations during the course of earlier development and production.

"The belief that PAW restricts well production stems undoubtedly from the fact that we certify to the oil producing states the quantity of oil which should be produced from each state during each month. Immediately after the outbreak of the war the discontinuance of tanker shipments from the Gulf to the East Coast, because of sinkings and need for tankers elsewhere, made it necessary that the production from the oil producing states be coordinated so as to make the most effective use of available pipe line and overland transportation facilities.

"The rates established for the states by PAW had only the force of persuasion, and not of law. In setting these rates we called upon the states whose production was most readily accessible to the East for maximum production.

"Never, since PAW has been establishing these rates, has the State of Illinois been able to produce as much as was requested of it.

"As more transportation facilities became available to the prolific fields in the Southwest, certified rates were increased. The fact is that, recently oil operators and state officials have complained to us that the rates for their states were too high.

"The only restrictions being placed on oil production today are imposed either by the state authorities, for the purpose of conservation, or by the lack of transportation facilities. Where more than one state must share in the limited available transportation facilities, PAW does recommend how the sharing should be done. To this extent and to this extent only does PAW participate in the control of production. Except in limited areas in the Southwest where sufficient transportation is not available, every oil field in the United States is producing at or substantially at maximum efficient capacity."

Amendment to P-98-c

Both used and new equipment in the petroleum industry may now be sold by one operator to a supplier as intermediary prior to its resale to another petroleum operator, without a direct resale being involved, under the terms of an amendment to Preference Order P-98-c, issued by the War Production Board.

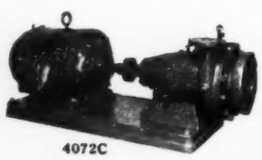
The Petroleum Administration for War, to whom administration of this order has been delegated by the WPB, explained that the amended order would allow suppliers to purchase, repair, and recondition used equipment and then seek a buyer, because the direct resale provision had been eliminated.

Suppliers may now also purchase and accumulate odds and end lots of new and used oil country tubular goods from various operators and re-sell complete strings to other operators. Neither preference ratings nor controlled materials allotment numbers may be used or are required in purchasing or re-selling either used or new materials acquired from petroleum operators.

New controlled materials acquired by suppliers from mills or equipment distributors under General Preference Order M-21-b-2 or the field stocks of oil country tubular goods, which are now being established under WPB directives, may be sold on the basis of allotment numbers. The newly established field stocks of tubular goods, established to encourage wildcatting, required special allotment numbers in addition and may not be sold until these special allotment numbers, including the symbol "FS," are obtained.

The PAW Materials Redistribution Program is now in effect and excess inventories are beginning to move freely within the industry. The new amendment to Order P-98-c will permit suppliers to function more nearly like merchandisers in a free market, speed up the redistribution of any excess inventories of either new or used materials now in the hands of petroleum operators and eliminate some of the paper work now necessary.

CENTRIFUGAL PUMPS RECIPROCATING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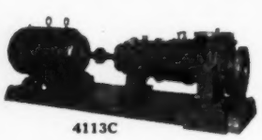
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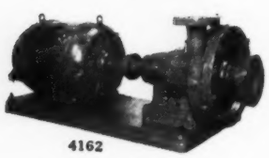
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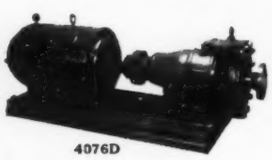
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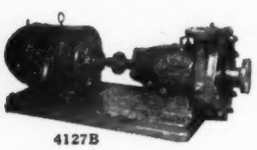
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The national synthetic rubber production is expected to reach over 240,000 tons at the end of 1943.

Our centrifugal pump is on the job in several different plants helping make this production possible.

Cuts are photographs of a few of the different pumps of which we have many duplicates that are operating at this time in synthetic rubber plants.

We are proud to be participating in something so vital to our war effort.

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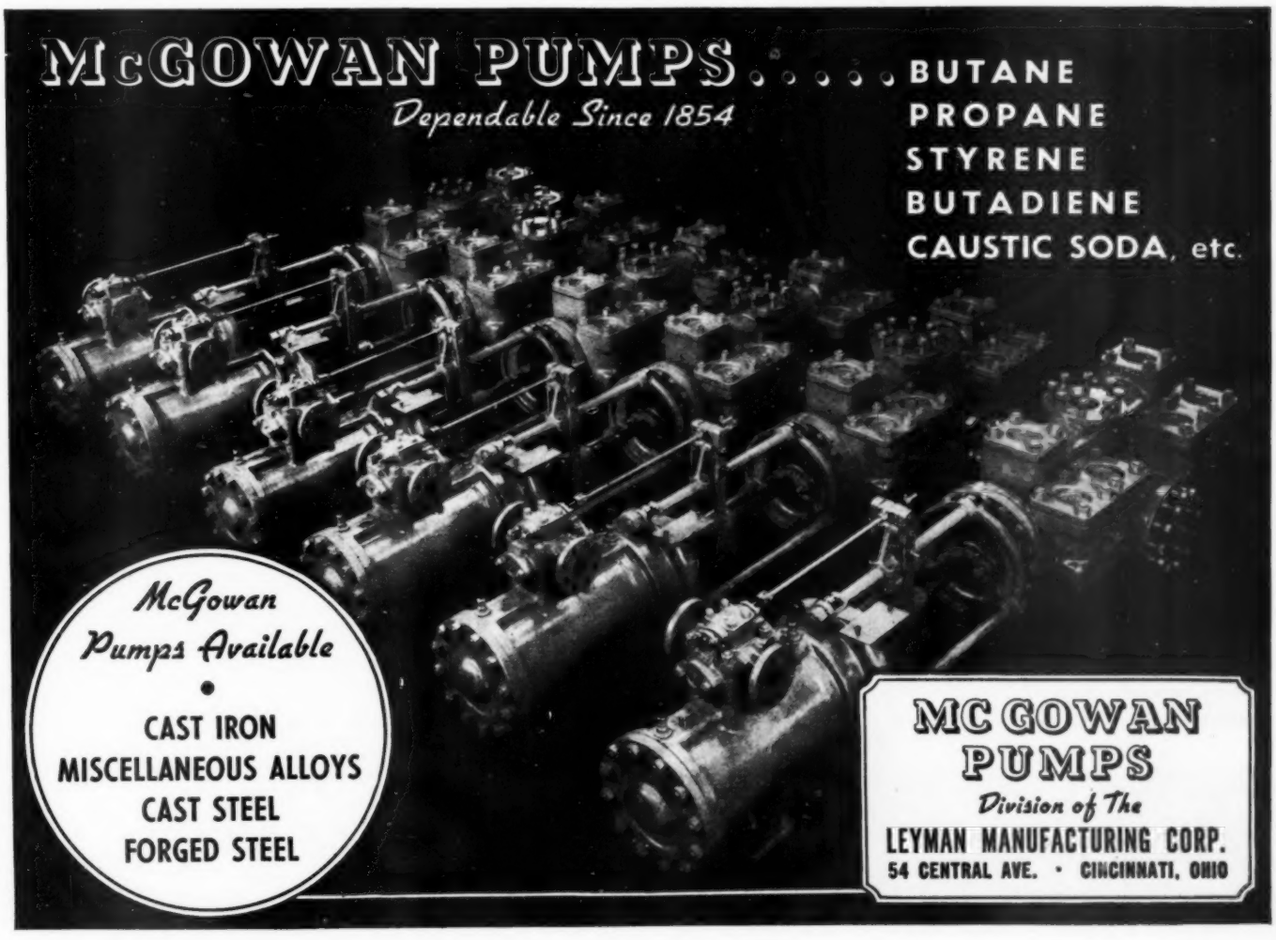

McSheehy Heads Wire Rope Sales

Wickwire Spencer Steel Company has appointed T. H. McSheehy sales manager of the Wire Rope Division, effective September 1.

In his new capacity, McSheehy will

T. H. McSHEEHY

supervise wire rope sales throughout the country. J. A. Old, who has been with the company a number of years, succeeds McSheehy as Pacific Coast sales manager.

McSheehy first joined Wickwire Spencer in 1923. Since then he has served in a variety of executive sales capacities, including hardware products manager, structural products manager, Chicago district manager and Pacific Coast manager, which position he held at the time of his new appointment.

McSheehy received a military education and served in the last war through April, 1919, as a lieutenant in the United States Navy.

Before joining Wickwire Spencer, he was with the American Steel and Wire Company.

He will have his headquarters in the company's general offices at 500 Fifth Avenue, New York 18, New York.

McKibbin Honored by Westinghouse

John M. McKibbin, manager, application data and training department, Westinghouse Electric and Manufacturing Company, has received his company's highest honor, the Order of Merit, for distinguished service to his company.

A bronze medal bearing a silver "W" and the inscription "Whom his fellow men delight to honor," was presented to McKibbin recently by B. W. Clark, Westinghouse vice president.

McKibbin's award was accompanied by this citation:

"In recognition of the distinguished service of John M. McKibbin for his exceptional talent in preparing and disseminating technical information which influences buying of the company's products; for developing the highly effective application training technique known as the "Product-of-the Month"; and for the imaginative way he has dramatized the obligation of Westinghouse people to increase production of war materials."

The technical information prepared under McKibbin's direction includes data on the proper application of electrical and steam equipment, how to procure the utmost productive capacity from it, and instructions on the maintenance and repair of apparatus. An extensive group of such bulletins have been given wide distribution and have found wide use among war industries.

The "Product-of-the-Month," is a continuing internal training program developed by McKibbin for the company's application groups. It employs visual and auditory presentations, product samples and models, together with application and market data on new products or applications.

E. A. Phoenix Promoted By Johns-Manville

The appointment of E. A. Phoenix as assistant manager of the Transite Asbestos Pipe Department of Johns-Manville has been announced by T. K. Mial, vice president in charge of industrial sales.

E. A. PHOENIX

Phoenix began his business career with the Kieselguhr Company of America in 1915. This firm later became The Celite Products Company, which became part of Johns-Manville Corporation in 1928. After serving in various sales and advertising positions, Phoenix was made assistant sales promotion manager in April, 1936. In May, 1942, because of his knowledge of the company's widely diversified product lines, he was transferred to the Priorities Department, a position which he held until his recent promotion.

In 1940, Phoenix became a member of the Johns-Manville Quarter Century Club, an honorary organization composed of those who have been with the company 25 years or more.

Phoenix will serve as general assistant to C. A. McGinnis, manager of the Transite Pipe Department, and will specialize in field sales and educational phases of the business.

An oil refinery operating a condenser cooling system found that scale and condenser tubes were slowing up production. Haering engineers were called in to make a survey. Haering Glucosates were applied. In a short time scale began to disappear and gasoline production went up 50 barrels a day.

It may be costing you more than 50 barrels a day not to send for a Haering engineer. Anyway, it won't cost you anything to have a survey made. Why not find out if we can increase your production.

Write for "*Cooling Waters*"

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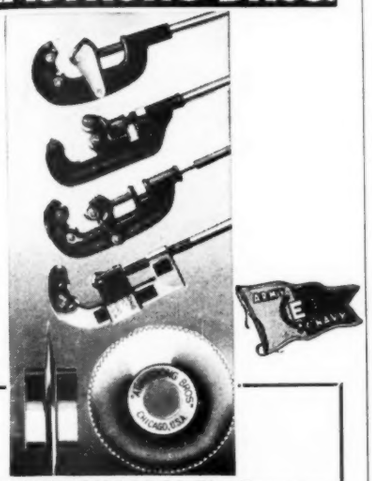
ARMSTRONG BROS.



All ARMSTRONG BROS. Pipe Cutters are made in all standard types. Each is a quality tool with hardened steel pins and rollers. "Saunder Type"—hardened end of thrust rod bears on inserted hard steel block (double life). In "Drop Forged" and "Combination" types, which take either 1 or 3 wheels, a replaceable hardened steel nut takes up thrust. In the "Barnes" type thrust rod threads through drop forged steel section.

ARMSTRONG BROS. Knife Blade Cutter Wheels (smooth or knurled) have thin penetrating edges that hold their keenness because they are machines from special vanadium tool steel, hardened and oil tempered. Fit all standard-make pipe cutters.

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Automatically removes and prevents scale and corrosion regardless of water or operating conditions.

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Write Today

Book Reviews

Oil and Petroleum Year Book, 1943. Published by Walter E. Skinner, 20 Copthall Avenue, London, E. C. 2. Price 12s. 6d., net; 13s.6d. post free abroad.

Complete and up-to-date particulars are given concerning 532 companies covering all branches of the oil industry. American and foreign companies are included.

The particulars of each company comprise names of directors and other officials, seat of operations, description of business, details of capital, dividends, and financial results.

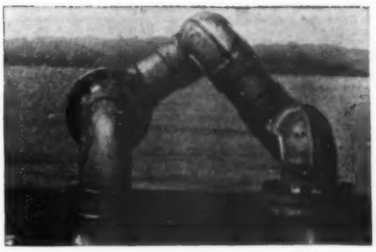
The many changes that have taken place since the last issue are recorded in its pages, and with the present difficulty of obtaining reliable information concerning some oil companies, particularly those in foreign countries, the book is of value to those interested in this important industry. Other useful features are the names and addresses of 215 managers and engineers and the names of the companies in the book with which they are connected, and a Buyer's Guide to Manufacturers of oil field and refinery equipment, comprising 299 headings.

•

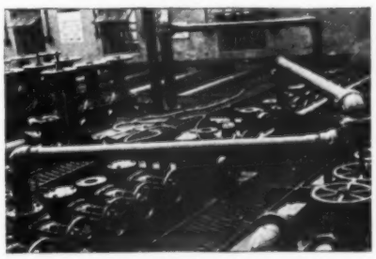
Petroleum Refinery Engineering, by W. L. Nelson. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York. Second edition. Pages, 715. Price, $6.

The second edition of "Petroleum Refinery Engineering," first published in 1936, includes several new chapters as well as additions and changes in the former material to bring it up to date. New chapters cover "Rebuilding Hydrocarbons," "Auxiliaries to Processing," and "Solvent Treating or Extraction Processes." The book contains new material on multiple-component fractionation, catalytic processes, and solvent dewaxing.

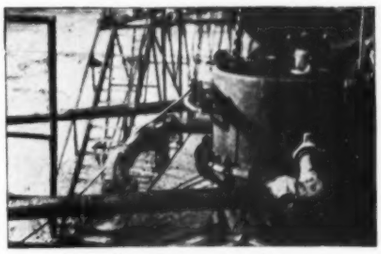
The author, W. L. Nelson, is a consulting petroleum and chemical engineer and professor of petroleum refining at the University of Tulsa, in Oklahoma. His object in presenting the volume, he stated in his preface to the first edition, was to point out the fundamentals of engineering design and processing. The book is an aid in clarifying many detail questions that arise during plant operation and encourages refining engineers to utilize the principles of chemical engineering more fully.



Chiksan Joints are ideal for expansion joints



Used in shipping terminals



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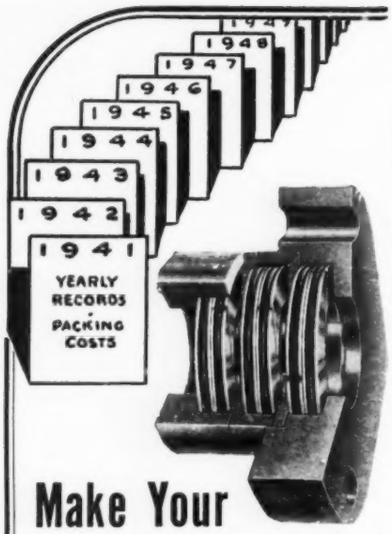

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There is a solution. Install France "Full-floating" Metal Packing in your engines, pumps and compressors. The result is increased efficiency. And each job lasts for years without maintenance expense. Saves money, too, in the long run.

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Joins Lincoln Electric

The Lincoln Electric Company, Cleveland, Ohio, manufacturers of arc welding equipment, announces the appointment of William J. Conley, former chairman of the Engineering Department of the University of Rochester, as consulting engineer. He will act as a Lincoln welding consultant for various industries, handling problems on mechanical and structural design utilizing welding, as well as metallurgical problems involving welding processes.

WILLIAM J. CONLEY

In connection with his work Conley will have charge of the company's welding educational activities, consisting of courses in welding engineering and design as well as lectures and talks on welding in the plant and in the field.

Receiving his degree in mechanical engineering from the University of Rochester in 1918, Conley soon afterwards was serving as a lieutenant in the U. S. Army Engineers. After the war, he entered upon his industrial career with the Gleason Works in Rochester and after two years returned to the University of Rochester as an instructor in applied mechanics.

T. A. Hicks Retires

Thomas A. Hicks, general chemist of the Universal Atlas Cement Company, United States Steel Corporation subsidiary, retired from active service August 31, 1943.

Hicks graduated in chemistry from the Case School of Applied Science in 1896. He became chief chemist of the Art Portland Cement Company at Ransoms, near Sandusky, Ohio, in 1897 and of the Whitehall Portland Cement Company at Cementon, Pennsylvania, in 1900. He joined Atlas Portland Cement Company as chief chemist at its Northampton, Pennsylvania, plant in 1904 and became chief chemist for the Atlas company in 1916 and for the Universal Atlas company in 1930.

Hicks was in charge of the original investigations on the development of Atlas White and Atlas Lumnite cements, and closely associated with the original manufacture of Unaflo oil-well cement, Atlas High-Early Strength cement, and the various types of modified cements.

Hicks has been a member of the American Society for Testing Materials for many years, a member of its Committee C-1 since 1914, of its gypsum committee since its inception, and formerly was a member of the textile committee. He will make his home in Ohio.

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You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

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This is a safe, efficient economical lantern that gives you a strong 1500 ft. beam or a bright floodlight. It is easy to carry, tilts and pivots, gives you lots of light where needed. Carries Underwriters' Laboratories recommendation for use in Class 1 Group D Hazards. Low price. See it at once. At Oil Well Supply Stores.

ECONOMY ELECTRIC LANTERN CO.
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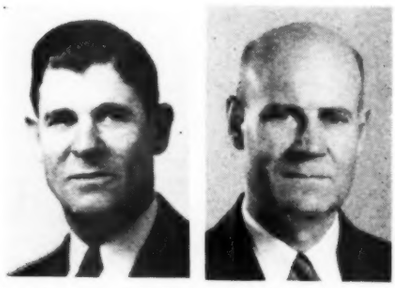
W. H. Cordes Heads American Steel & Wire Division

Wilmer H. Cordes, advertising manager, American Steel and Wire Company, Cleveland, Ohio, has been appointed head of a newly created sales research and development division of the company in addition to his other duties.

The new division will carry on the study of postwar markets for existing products of the company and also will study and investigate the effect of the use of substitute materials and new application of old ones. In addition, it will explore ideas for new products and possible new uses for normal products. Also to be considered is the expected need for altered distribution and merchandising methods in the face of changes in existing practices. The new division will aid in formulating and recommending plans and programs for the new market era.

Cordes has been with American Steel and Wire Company for 30 years, most of which time he has been in the advertising department. He has been manager of sales promotion and advertising since 1935.

Form Drilling Firm



O. D. WILLIAMS C. M. COPELAND

O. D. Williams and C. M. Copeland have severed their connection with Helmerich and Payne, Inc., to form Williams-Copeland Drilling Company. Headquarters are in Tulsa, Oklahoma.

The company is operating rotary drilling tools in Kansas at present and plans to extend its operations into Oklahoma. In addition, casing pulling and well salvaging work is being done.

Williams has been with Helmerich and Payne for the last 16 years and for 7 years has been rotary drilling superintendent. Copeland has been with the company for 7 years, in charge of cable tool drilling, production, and engineering.

Ralph Gwilliam, formerly on the auditing staff of the Ohio Oil Company and later with Helmerich and Payne, is office manager for the firm.

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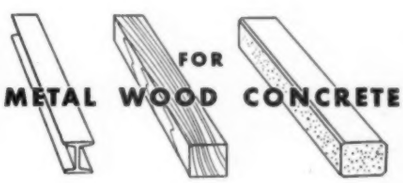
A GENERAL PURPOSE COLD-APPLIED THERMOPLASTIC COATING FOR A WIDE RANGE OF APPLICATIONS

Amercoat No. 33 Thermoplastic Coating is the result of two years of careful development and exhaustive test both in the laboratory and in the field. It meets the urgent demand for an inert, easy-to-apply protective coating for wood, metal and concrete.

Amercoat No. 33 is used as a coating for structural steel, floors, filters, tanks, concrete walls and floors, machinery, ship bottoms and boottopping, concrete urinals, shower bases, laundry tubs... wherever buildings and equipment are exposed to corrosive fumes or the corrosive action of salt water, fresh water or various mild acids or caustics.



Amercoat No. 33 Thermoplastic Coating is composed of the correct combination of the most inert synthetic resins obtainable. It comes in liquid form and is easily applied with ordinary industrial paint spray equipment or by brush. It may be applied in any number of coats required for any particular condition. It is odorless, tasteless, resistant to moderate abrasion and is dielectric to a high degree.

***Amercoat* No. 33 does not replace, nor is it a substitute for other *Amercoat* Compounds which have been developed for more highly specialized requirements.**

Amercoat DIVISION

Write for Bulletin No. 33 which gives complete data on AMERCOAT No. 33 and the many uses for which it is suited.

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SPIRAL PACKERS
Hold Fast to the Formation
When the Guiberson Spiral Packer reaches a predetermined level, the spiral is collapsed, biting into the formation and holding fast. Result: a positive pack-off that stays put. Practical, performance-proved and available in tubing packers, casing packers, standard plugs, collapsible plugs and washdown plugs . . . Write —or consult your Composite Catalog.
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TRADE LITERATURE

What to Write For

TWELVE FLOW DIAGRAMS and pictures of various Adjust-O-Feeders and Treet-O-Units make a graphic and attractive booklet that has been released by % Proportioneers, Inc. %. The company deals in automatic proportioning equipment for the process industries, including treating, blending, diluting, and sampling. Write for Bulletin No. 1700 to % Proportioneers, Inc. %, 9 Codding Street, Providence, Rhode Island.

BULLETIN NO. 116, which describes the Edge Moor process equipment fabrication for chemical industries, has been released. It will be sent upon request to the manufacturers, Edge Moor Iron Works, Inc., Edge Moor, Delaware, makers of water tube boilers, process equipment, and welded steel products.

"VALUABLE FACTS ABOUT THE USE AND CARE OF WIRE ROPE" is the title of a booklet sent free upon request to American Steel and Wire Company in Cleveland, Ohio; Chicago, Illinois, or New York, New York, or to Columbia Steel Company in San Francisco, California. Proper lubrication of wire rope is discussed and the benefits enumerated.

MORE EFFICIENT MAINTENANCE is possible with the "Kingclip" valve, according to Circular 504, which is available by request to The Lunkenheimer Company, Cincinnati 14, Ohio. A description of the valve and the reasons for the minimum maintenance are given in the publication.

A REVISED AND ENLARGED EDITION has been published of "Simplified Method for Calculation of Pipe Wall Thickness for Various Pressures and Temperatures Based on A.S.T.M. and A.P.I. Specifications and the A.S.A. Code for Pressure Piping." The volume can be obtained upon request by writing Midwest Piping and Supply Company, Inc., 1450 South Second Street, St. Louis 4, Missouri, and mentioning Bulletin 43-A. Tables in the booklet are important aids in selecting pipe wall thicknesses.

CHARACTERISTICS AND SPECIFICATIONS of National and Karbate materials are described in a new bulletin on carbon and graphite products. It has been published by National Carbon Company, Inc., 30 East 42nd Street, New York, New York, and is available upon request. Among the items included in the pamphlet are packing and seal rings, tube and shell heat exchanger, raschig rings, carbon and graphite brick, etc.

OIL FIELD ENGINES that can be converted from natural gas to gasoline without interrupting operations are shown in a new publication called "Waukesha Oil Field Engine Bulletin 1079." Copies are available without charge, according to Waukesha Motor Company, Waukesha, Wisconsin. Multi-fuel engines and their advantages are the subject of the material.

DIESEL POWER and its use are discussed in a new book released by Fairbanks, Morse and Company, 600 South Michigan Avenue, Chicago 5, Illinois. Called "Fairbanks-Morse Diesels for Profitable Power," the publication includes a brief history of the company along with descriptions of various designs, their manufacture and service facilities.

A NEW TYPE of light-reflecting floor installed in a number of aircraft plants is described in a new 24-page book, "Light From Floors Speeds War Production," published by Universal Atlas Cement Company, Chrysler Building, New York. It was prepared in collaboration with various authorities on illumination, design, and construction. The floors are built of white cement instead of darker materials.

YEL-O-BAK BULLETIN has been released for free distribution by The Refinery Supply Company, 621 East Fourth Street, Tulsa, Oklahoma. The special designing and efficient performance of Yel-O-Bak thermometers are graphically reviewed in the booklet. Copies will be sent upon request.

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285 LBS.

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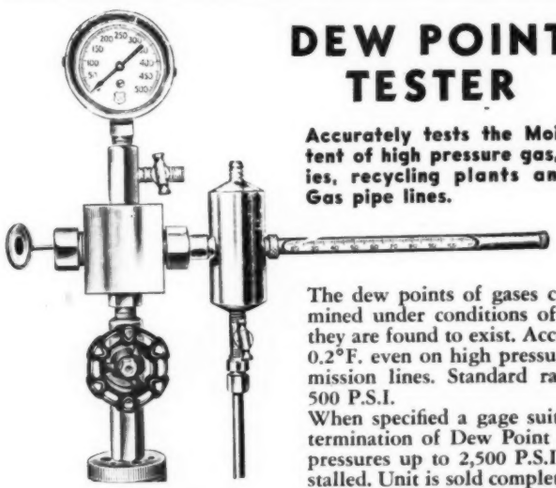

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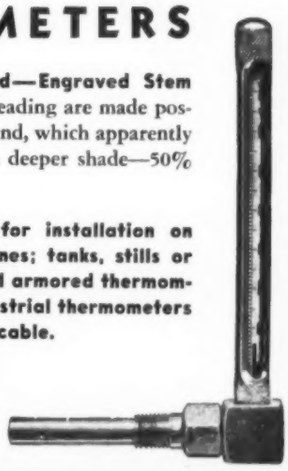
Especially recommended for installation on oil, gasoline and water lines; tanks, stills or any place requiring a small armored thermometer and where larger industrial thermometers are not conveniently applicable.

Special Sizes and Ranges made to your specifications and requirements. Write for YEL-O-BAK *Bulletin.*



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EXPLOSION DOORS • ACCESS DOORS • AIR DOORS
BURNER BLOCKS • FURNACE OBSERVATION WINDOWS

Fred Murray Elected President Oil Well Supply

The election of Fred F. Murray as president of the Oil Well Supply Company was announced following a meeting of the board of directors of the company in Dallas, Texas.

FRED F. MURRAY

Oil Well Supply Company is a subsidiary of the United States Steel Corporation. The election of Murray signifies the first time a presidency of the Oil Well Supply Company has come to the Southwest. As such, it also signifies the first establishment of the presidency of a U. S. Steel Corporation subsidiary in the Southwest.

In commenting on the selection, Benjamin F. Fairless, president of United States Steel Corporation, said:

"The election of Mr. Murray as president of this important subsidiary is a source of genuine satisfaction. He is a capable executive with many years experience in the oil well supply business. This is one of the Southwest's most important industries and constitutes a field in which Mr. Murray is well known."

Murray succeeds Benjamin F. Harris of Pittsburgh, Pennsylvania, who resigned some months ago. Murray has been identified with the oil well supply business since early 1929, in which year he became vice president of Wilson Snyder Manufacturing Company of Pittsburgh. That company was acquired the same year by Oil Well Supply Company, and at the same time Murray was elected vice president of Oil Well Supply Company. He moved to Oil City, Pennsylvania, where he was in charge of manufacturing.

In 1930, Oil Well Supply Company became a U. S. Steel Corporation subsidiary, and subsequently Wilson Snyder was made a division of "Oil Well."

Early in 1936, four years after general headquarters of the company had been transferred from Pittsburgh to Dallas, Murray moved to Dallas as the ranking vice president.

Murray is president of the Petroleum Equipment Suppliers Association and a director of the American Petroleum Institute. He attended Stevens Institute of Technology in New Jersey, from which he was graduated with a degree in mechanical engineering. He is a member of the American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers.

The Oil Well Supply Company, during the years of its establishment in Texas, has become one of the largest producers and distributors of oil field equipment in the world. It operates three manufacturing plants in the steel producing region of the East, and approximately 90 branch stores and field offices, in addition to its export representation in the principal oil producing countries.

Its general offices in Dallas, which direct the overall operations of the company, employ more than 200 persons.

Its distribution channels, emanating from Dallas, extend to its own offices as far distant as Buenos Aires, Argentina, and Calgary, Alberta, and supplies distributed through near and distant offices reach not only into every field in the Southwest and in the nation, but into the distant projects of Patagonia and the new oil well explorations in the Arctic Circle.

Robert L. Crook Rejoins "Oilwell"

Robert L. Crook has re-entered the employ of Oil Well Supply Company, at San Antonio, Texas. Bob represented "Oilwell" in South America from 1933 to 1937. He had previously served as driller for British interests in Burma and for American companies in Argentina, Bolivia, Venezuela, and Java, and as drilling superintendent in Borneo.

Baker Oil Tools Wins "E" Flag

Colorful ceremonies, attended by about 700 persons, marked the presentation to Baker Oil Tools, Inc., at 6000 South Boyle Avenue, Los Angeles, California, of the Army-Navy Production "E" Flag for "excellence in the production of war materiel.

The presentation was made by Col. K. B. Harmon, Chief, San Francisco Ordnance District, to R. C. Baker, president, representing the company, and Betty Rice, C. A. Jensen, and A. C. Pazdernik, representing employees.

E. P. Holder New President Wickwire Spencer

E. Perry Holder, president of the Vulcan Iron Works, Wilkes-Barre, Pennsylvania, has been elected president of the Wickwire Spencer Steel Company, Charles Allen, Jr., chairman of the executive committee, has announced. Holder succeeds E. C. Bowers, who has been connected with the company since 1911 and has been president since 1926. Bowers has resigned because of serious illness but will continue as a member of the board of directors and executive committee and act in an advisory capacity. Carl I. Collins will continue as executive vice president in charge of production.

E. PERRY HOLDER

A graduate of Phillips Exeter Academy and of Yale College with the Class of 1918, Holder served during the last war with the United States Army. While in college he was a laboratory assistant in biology and taught in New Haven High School.

Virtually his entire business career has been in executive positions connected with the manufacture and sale of steel and other metal products. During the N. R. A. he served on advisory boards of three industrial organizations—laundry machinery, gasoline pump, and centrifugal manufacturers. He was executive vice president of American Machine and Metals, Inc., New York City, until 1937 and since 1940 has been president of the Vulcan Iron Works of Wilkes-Barre in complete charge of all operations. He is resigning the latter position to become president of Wickwire Spencer.

Firms Merge

The Chemical Process Company of Breckenridge, Texas, and the Independent-Eastern Torpedo Company of Tulsa, Oklahoma, and Findlay, Ohio, have been merged into a $10,000,000 organization. The Chemical Process Company will retain its corporate entity as a division of the Independent-Eastern firm.

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"BIG INCH" — the world's mightiest petroleum highway — needed gates that would control and direct its daily 300,000-barrel flow of liquid traffic. Ludlow Valves — mighty, themselves, yet mechanically simple and smooth in operation — got the call because that's the kind of responsibility that Ludlows have always specialized in.

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Construction Features: Self-releasing 30° angle wedges and free-floating gates, self-adjusting to seats, afford smooth, trouble-free performance, long service. Rings are cleaned throughout stroke action. Gates are wedge-locked directly opposite ports and completely unwedged before raising. Ample tolerances provide easy action. Simple construction permits easy replacement of parts.

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Helps Crew

Saves Water

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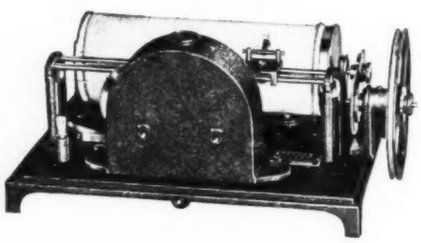

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Automatic, graphic records of tank levels from which volume of flow per unit of time may be determined.

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Automatic records reduce operating costs and conserve manpower!

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Maritime Award to Wm. Powell Co.

The Maritime Commission's Award of Merit was recently presented to both plants of the Wm. Powell Company of Cincinnati, Ohio, for outstanding performance in the production of valves not only for the ships of the Victory Fleet but also for the many industries engaged in making the machinery,

materiel, and equipment for these ships. This company had already received the Army-Navy "E" Awards.

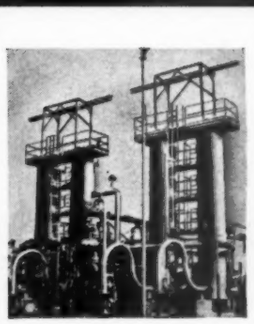
The presentation of the Maritime Commission's Award was made at an impressive ceremony in the yard of Plant No. 1. Colonel Willard F. Rockwell, Director of Production, United States Maritime Commission, presented the "M" Burgee, the Victory Fleet Flag, and the Labor Merit Badges. The acceptance speech in behalf of the company was made by George E. Weitkamp, first vice president and secretary. The Labor Merit Badges were accepted by James Coombe, president, The Wm. Powell Company, representing management and Oliver F. Gang, vice president of the company; and by Fred Phillips, Oscar Karhoff, Fred Weber, and Edwards Bootes, president of Local 1858, United Steel Workers of America, C.I.O., who made the speech of acceptance on behalf of the workers.

G. S. Colley, Jr., Japanese Prisoner

Unreported in the South Pacific war zone since the fall of Manila, George S. Colley, Jr., vice president of W. A. Bechtel Company, is alive and well on Borneo, although a Japanese prisoner. This news, transmitted on August 21 through the International Red Cross headquarters at Geneva, will be happily received by his many friends in the petroleum and heavy construction industries.

Colley has been identified prominently with the Bechtel organization's extensive pipe line construction activities for many years as the executive in charge of this phase of the company's work. When war was declared, he was engaged in building augmented naval and air facilities at Cavite on Manila Bay, directing construction for his company as project manager under ocean-wide naval contracts being executed by Contractors Pacific Naval Air Bases. Both at Cavite and across the Bay on the cliffs of Bataan the construction organization continued its work under constant attack until forced to capitulate by the proximity of Japanese occupational forces.

In early January, 1942, Colley, together with Mrs. Colley, Mr. and Mrs. Harry Webber, and Ashton Laidlaw left Manila in a motor launch. They were traced as far as Balabac Strait northeast of Borneo, and before reaching this point the party had transferred to a small sail boat. From that time until August 21, 1943, no word was received of the whereabouts or fate of this party. The news came in time to dispatch greetings from home by the Swedish ship, the S. S. Gripsholm.



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In dehydrating natural gas — whether for pipe-line transmission and distribution, for repressuring, or for whatever purpose, FLORITE is likely to be found as the drying agent. Recent examples of approval have been noteworthy — names on request. Such demonstrations as the one represented below give the reason.

Long-term effectiveness, resulting in economy of operation, sums up the advantage. FLORITE selectively adsorbs 4 to 20% its weight of water, and is regenerated by heating to 350°F. Full details on request. Correspondence is invited.

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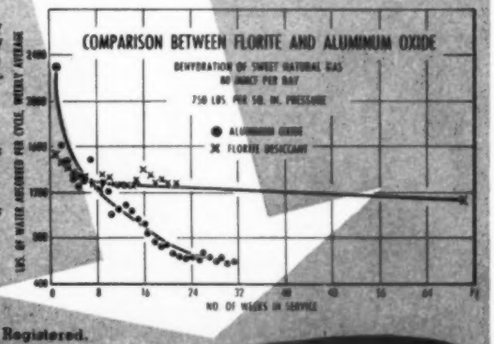
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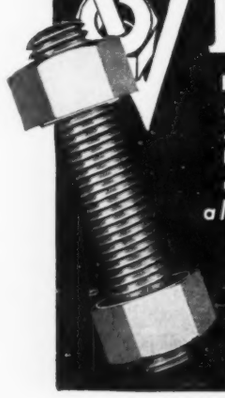

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MEETINGS

National Petroleum Association, Annual Meeting—September 21 and 22, Waldorf Astoria Hotel, New York City.

Interstate Oil Compact Commission—September 24 and 25, Santa Fe, New Mexico.

American Association of Oilwell Drilling Contractors, Annual Meeting—October 5 and 6, Houston, Texas.

California Natural Gasoline Association, Monthly Meeting—October 7, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Gas Association, Annual Meeting—October 11, 12, and 13, Jefferson Hotel, St. Louis, Missouri.

Mid-Continent Oil and Gas Association, Annual Meeting—October 14 and 15, Blackstone Hotel, Fort Worth, Texas.

Independent Petroleum Association of America, Annual Meeting—October 25, 26, and 27, Fort Worth, Texas.

American Petroleum Institute, Annual Meeting—November 8, 9, 10, and 11, Palmer House, Chicago, Illinois.

Exposition of Chemical Industries—December 6, 7, 8, 9, 10, and 11, Madison Square Garden, New York City.

Petroleum Industry Electrical Association and the Petroleum Electric Supply Association—Last week in April, 1944, Dallas, Texas.

A. J. Wadhams Passes Away

Albion James Wadhams of Dongan Hills, Staten Island, New York, a vice president and manager of the Development and Research Division of the International Nickel Company, Inc., in New York, died at his summer home at Elizabethtown, New York, on August 22 of a heart attack. He was 68 years old.

Born at Annapolis, Maryland, son of the late Rear Admiral (United States Navy) Albion V. and the late Caroline (Henderson) Wadhams, he was graduated from the United States Naval Academy in 1895. Wadhams served as an ensign and later as a lieutenant (j.g.) in the United States Navy from 1895 to 1901.

He has been with The International Nickel Company and its predecessor companies since 1901. Wadhams joined the Orford Copper Company at Bayonne, New Jersey, on March 1 of that year. He was transferred from there in 1904 to the American Nickel Works at Camden, New Jersey, acting as superintendent until 1912. From 1912-1918 he was assistant general superintendent of Orford Works of International Nickel, becoming general superintendent in 1918. Wadhams was named manager of the company's Development and Research Division in New York on April 1, 1922. In addition to this position, he has been a vice president of The International Nickel Company, Inc., since October, 1935.

Wadhams was a member of the American Iron and Steel Institute, American Institute of Mining and Metallurgical Engineers, American Society of Naval Engineers, American Society for Metals, Mining and Metallurgical Society of America, Navy League of the United States, New York Electrical Society, Princeton Engineering Association, Society of Naval Architects and Marine Engineers, The Newcomen Society of England, United States Naval Institute and American Association for Advancement of Science.

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ROCKFORD *Industrial* CLUTCHES *and* POWER TAKE-OFFS

SEND FOR THESE HANDY BULLETINS ON POWER TRANSMISSION CONTROL

Give capacities, dimensions and specifications. Show HOW exclusive features of ROCKFORD CLUTCHES and POWER TAKE-OFFS are utilized to give your products competitive advantages.

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Turns night into day around rigs, pipe-lines, loading points, etc. . . . makes it easier and surer to keep production moving. Lantern is easily carried by fixed "spade grip" handle or set on movable stand for steady, focused beam. Justrite ruggedness and "twin-bulb" feature guarantee years of dependable, trouble-proof operation.

Inspector's Lantern (46-W) highly polished 7" reflector or globe can be removed independently. Twin-bulbs guard against light failure. Powerful 1500 foot beam.

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The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.

The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.

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Before the tooth was finally worn out, it had operated a total of 120 days!

Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 3/16", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

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Stop wear... Eliminate Repair

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OIL PRODUCTION MAINTENANCE, INC. SAYS:
HERE'S THE RIG WE'VE ALWAYS WANTED!

FOR ROTARY DRILLING TO 5,000 FEET WITH 4½-INCH DRILL PIPE, OR WORKOVER JOBS TO 10,000 FEET

This streamlined, fast operating set-up would satisfy the most particular drilling contractor or production superintendent. This rig has the light weight and compactness necessary for fast moves and the power and sturdiness necessary for deep drilling and workover jobs.

THE DRAW WORKS

The Model S draw works is powered with a 202 HP Waukesha engine which drives through the "Cardwell" five-speed, even-step transmission to the drum and rotary table. The friction clutch drives enable the drum clutch to be engaged and the drill pipe lifted without stopping the rotary table.

SEPARATE PUMP

Using a 202 HP Waukesha engine as a prime mover, the "Cardwell" two-speed drive operates the 7 x 14 Gumbo Buster mud pump. This two-speed drive to the pump furnishes the normal operating pressure in the high drive and extremely high pressure in the low drive for killing wells and to break over and circulate the mud.

The pressure of the low drive for instant use provides a safety factor in high pressure workover jobs comparable only to a stand-by pump.

Due to the lower pump speeds at which the higher pressure is obtained, a pump can be operated for short, intermittent periods without damage.

Either pump speed is instantly available.

Owned by Oil Production Maintenance, Inc., Houston, Texas

CARDWELL ALLSTEEL
THIS TRADE MARK INSURES HIGHEST QUALITY AT LOWEST PRICE

CARDWELL MFG. CO. INC.

FORMERLY ALLSTEEL PRODUCTS MFG. CO.
P.O. Drawer 2001 · Cable Addresses: ALLSTEEL, WICHITA; CARDSTEEL, NEW YORK
Wichita, Kansas, U. S. A.

"CARDWELL" RIGS ARE STRONGER, WEAR LONGER AND WEIGH LESS

HARNESSING THE KICK OF 1000 HORSES

• Here's the drive cog of a tank.

It tugs that tread with a yank that has as much as a thousand horsepower back of it.

And Elastic Stop Nuts—a single one on each lug—hold that tread.

This is just one of the war-fastening jobs Elastic Stop Nuts are doing. There are more of them on America's planes, tanks, guns, naval vessels and production equipment than all other lock nuts combined.

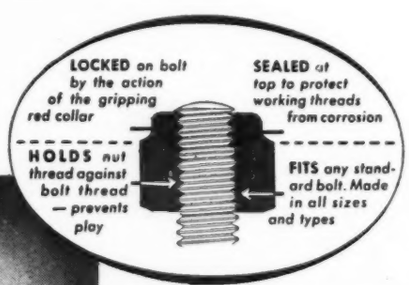
You know why.

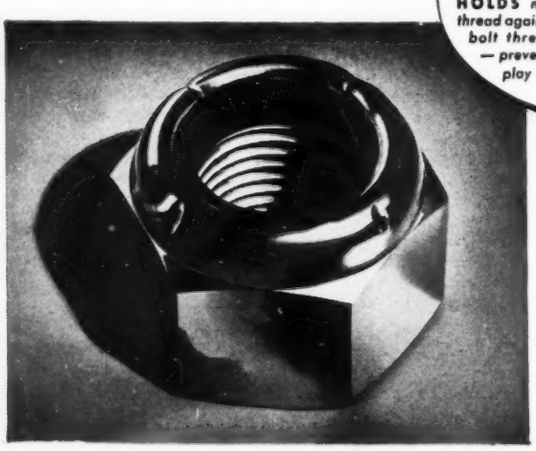
It's because of the red elastic collar which makes these nuts lock fast and stay put in the face of vibration—anywhere on the bolt.

This collar molds itself tightly to the bolt. It keeps the nut and bolt threads in pressure contact. The nut can't wiggle or turn.

Later on, these nuts will be available to do this kind of job for industry. Products will be better, stronger, longer-lasting. Production routine will be free of frequent "take-ups," inspections and replacements.

If your postwar planning includes a fastening problem, let us know. Our engineers will gladly suggest a way to solve it and recommend the appropriate Elastic Stop Nut.


LOCKED on bolt by the action of the gripping red collar
SEALED at top to protect working threads from corrosion
HOLDS nut thread against bolt thread — prevents play
FITS any standard bolt. Made in all sizes and types



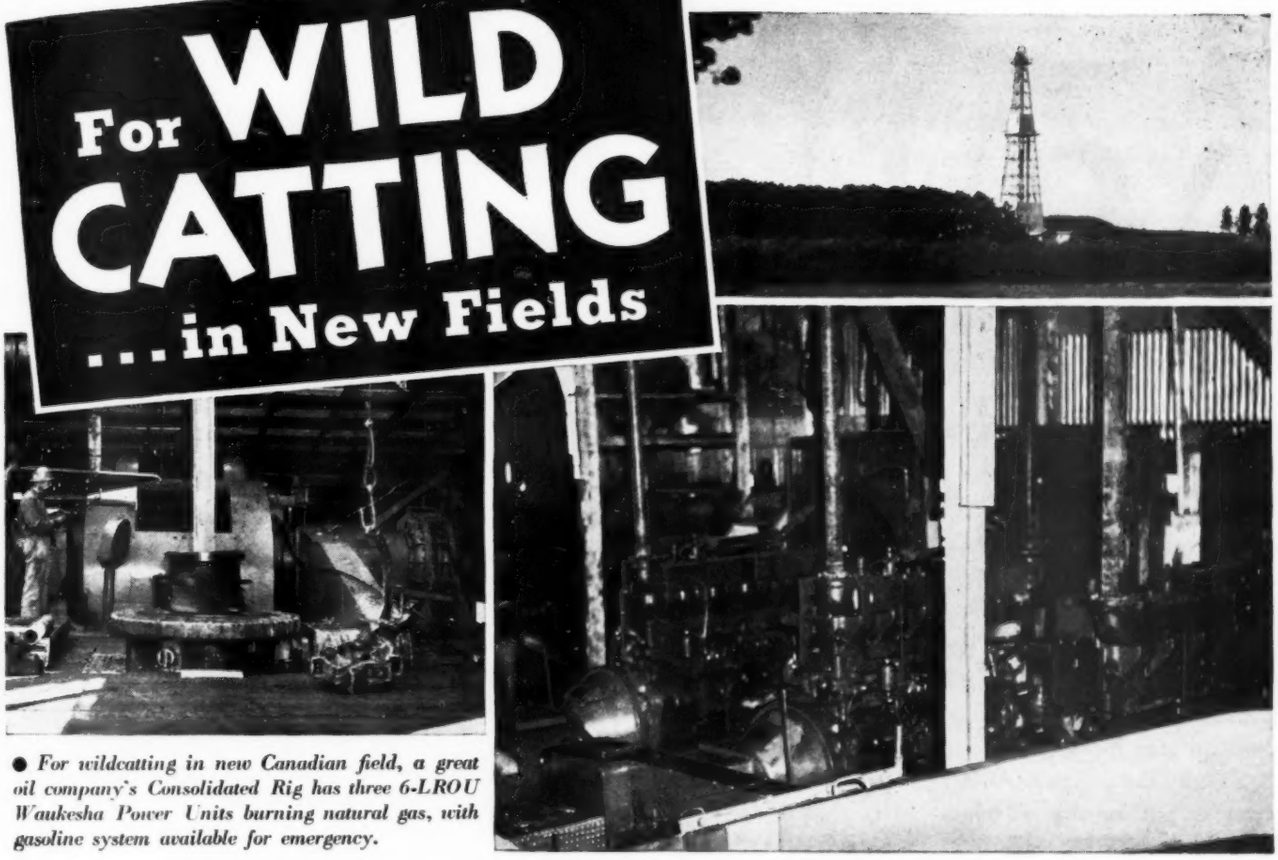
ELASTIC STOP NUTS

Lock fast to make things last

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA
UNION, NEW JERSEY AND LINCOLN, NEBRASKA

For WILD CATTING ...in New Fields



● *For wildcatting in new Canadian field, a great oil company's Consolidated Rig has three 6-LROU Waukesha Power Units burning natural gas, with gasoline system available for emergency.*

WAUKESHA *Oil Field* ENGINES

Convertible from Natural Gas to Gasoline ...without interrupting operations

★ Wildcatting in a new field—one of Canada's foot-hill regions noted for its consistently hard formations—these engines have drilled 2500 to 2600 ft. in what is expected to be an 11,000-ft. hole.

At least 250 to 400 bits will be used and six months to a year will be required, if this drilling project is completed as planned.

This oil company is using one of the best equipped, best rigged up mechanical power rigs of the larger type. It's an Ideal Type 125 Consolidated Rig, with three big Model 6-LROU Waukesha Oil Field Power Units, 8½" x 8½", 2894 cu. in. displ., developing 375 to 400 hp. *each.*

Coupled through hydraulic transmission to the mud pumps, rotary table and draw works, these Waukesha Engines give all the responsive smoothness, with fast flexible power, that deep drilling demands . . .

And more! These Waukesha Power Units burn natural gas. But, in new fields like this one, the supply of natural gas often runs short. It happened here. And butane wasn't available either. But these Waukeshas are *Multi-Fuel* Engines—with a gasoline system immediately available. Drilling went right on without interruption. *Get Waukesha Oil Field Engine Bulletin 1079.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS., NEW YORK, TULSA, LOS ANGELES

The Petroleum Engineer, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, seventh floor Allen Building, Dallas, Texas. Supscription price, $2.00 per year, $3.00 for 2 years, 25c a copy. Entered as second-class mail matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

AQUAGEL

OVERCOMES MANY DRILLING DIFFICULTIES

AQUAGEL has been used for many years in both rotary and cable tool drilling to overcome drilling difficulties from grass roots to completion.

When spudding in, AQUAGEL controls surface water, checks caving and consolidates loose formations. The thin mud cake which AQUAGEL provides is particularly advantageous when cementing casing because a tighter bond between casing and hole is effected and there is less chance of water intrusion. When there is a thick cake on the walls of the hole there is greater probability of water channelling between the walls of the hole and the cement. When water sands separate oil sands, this is particularly important.

When AQUAGEL is used, no mud change is necessary when entering the producing zone because of its low water loss. When cleaning up, the thin AQUAGEL filter cake disintegrates easily into small, fragile pieces which readily swab through the liner. Its quick removal from the face of the formation exposes all the oil sand. Swabbing is reduced and higher potentials are realized.

MAKES STRAIGHT DRILLING SAFER, FASTER, MORE ECONOMICAL

AQUAGEL extends the interval of straight drilling. Lost circulation, and heaving and sloughing caused by water infiltration are reduced to a minimum. AQUAGEL is economical because it yields about 100 barrels of mud per ton. This high yield means less to carry, less to store and less to handle. After completion, spare sacks of AQUAGEL can be easily and quickly moved to another location without loss.

Patent Licenses, unrestricted as to sources of supply of materials, but on royalty bases, will be granted to responsible oil companies and operators to practice the inventions of any and/or all of United States Patents Nos. 1,807,082; 1,991,637; 2,041,086; 2,044,758; 2,064,936; 2,094,316; 2,119,829; 2,214,366; 2,294,877; 2,304,256 and further improvements thereof. Applications for Licenses should be made to Los Angeles office.

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
BAROID SALES OFFICES: LOS ANGELES • TULSA • HOUSTON

BAROID PRODUCTS . . . BAROID and COLOX, AQUAGEL, FIBROTEX, BAROCO, STABILITE, AQUAGEL-CEMENT, SMENTOX, IMPERMEX, ZEOGEL, MICATEX, ANHYDROX, TESTING EQUIPMENT, BAROID WELL LOGGING SERVICE

NO-OX-ID

IRON + OX = RUST

rust preventive

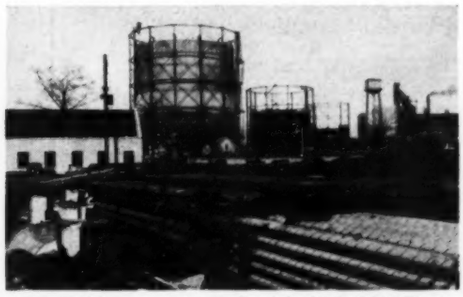
NO-OX-ID-IZED WRAPPER FOR PIPE LINES

2-WAY TREATMENT for *Rust Rash*

NO-OX-ID and NO-OX-IDized Wrappers are designed for complete treatment of pipe lines. For tanks and other steel structures, NO-OX-ID coating, which may be applied by brush or spray, renders passive any pits or corrosion which may be present and prevents further corrosion. NO-OX-IDized Wrappers are reinforced to resist soil action . . . they are thoroughly impregnated with NO-OX-ID to repel moisture even on pipe lines laid in rivers or through swamps.

DEARBORN CHEMICAL COMPANY
Dept. L, 310 S. Michigan Ave., Chicago 4
New York • Los Angeles • Toronto

Service lines under city streets are doubly protected with NO-OX-ID and NO-OX-IDized Wrapper.

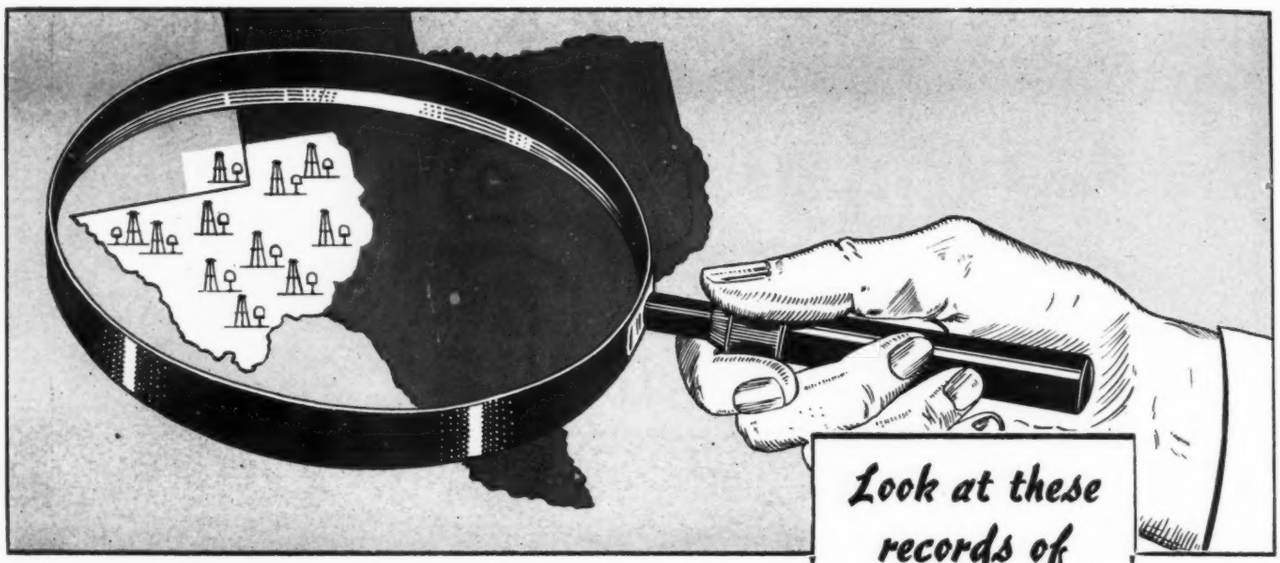


Gas holders are coated with NO-OX-ID A Special X. Pipe in foreground has been protected with NO-OX-ID and NO-OX-IDized Wrapper by machine in a single operation.

Pipe lines through swamps and in river beds are very effectively protected against moisture penetration.

[For Victory, Buy United States War Bonds and Stamps]

NIXON GAS-LIFT
Proves Exceptional Efficiency



. . . in Permian Basin

Despite large volumes of sand, Nixon Surface Control Gas-Lift Systems are establishing some remarkable records for economy of production and maintenance. With several hundred units operating in this area, there have been extremely few pulling jobs. In the sub-surface equipment, the small number of parts subject to sand cutting have proven highly resistant to this action.

High gas pressure throughout this area makes it possible to operate the Nixon Gas-Lift on all leases . . . and one man is able to handle the operation of many units. Because this system requires no heavy transportation, extensive foundation or heavy operating machinery, the Nixon Gas-Lift is quickly and economically installed.

Consult a Nixon Gas-Lift engineer before you install any means of fluid lifting. Write your nearest Wilson Supply Co. store or sales office.

Look at these records of performance

selected at random from our files of hundreds. We can put your lease on the same kind of efficient, economical production.

LEASE A

Number of wells equipped with Nixon Gas-Lift	42
Average months of operation per well	17.9 months
Average cost of repair parts per well per day	$.048

LEASE B

Number of wells equipped with Nixon Gas-Lift	29
Average months of operation per well	10.5 months
Average cost of repair parts per well per day	$.0026

LEASE C

Number of wells equipped with Nixon Gas-Lift	37
Average months of operation per well	11.2 months
Average cost or repair parts per well per day	$.0058

LEASE D

Number of wells equipped with Nixon Gas-Lift	16
Average months of operation per well	13 months
Average cost of repair parts per well per day	$.022

WILSON SUPPLY COMPANY

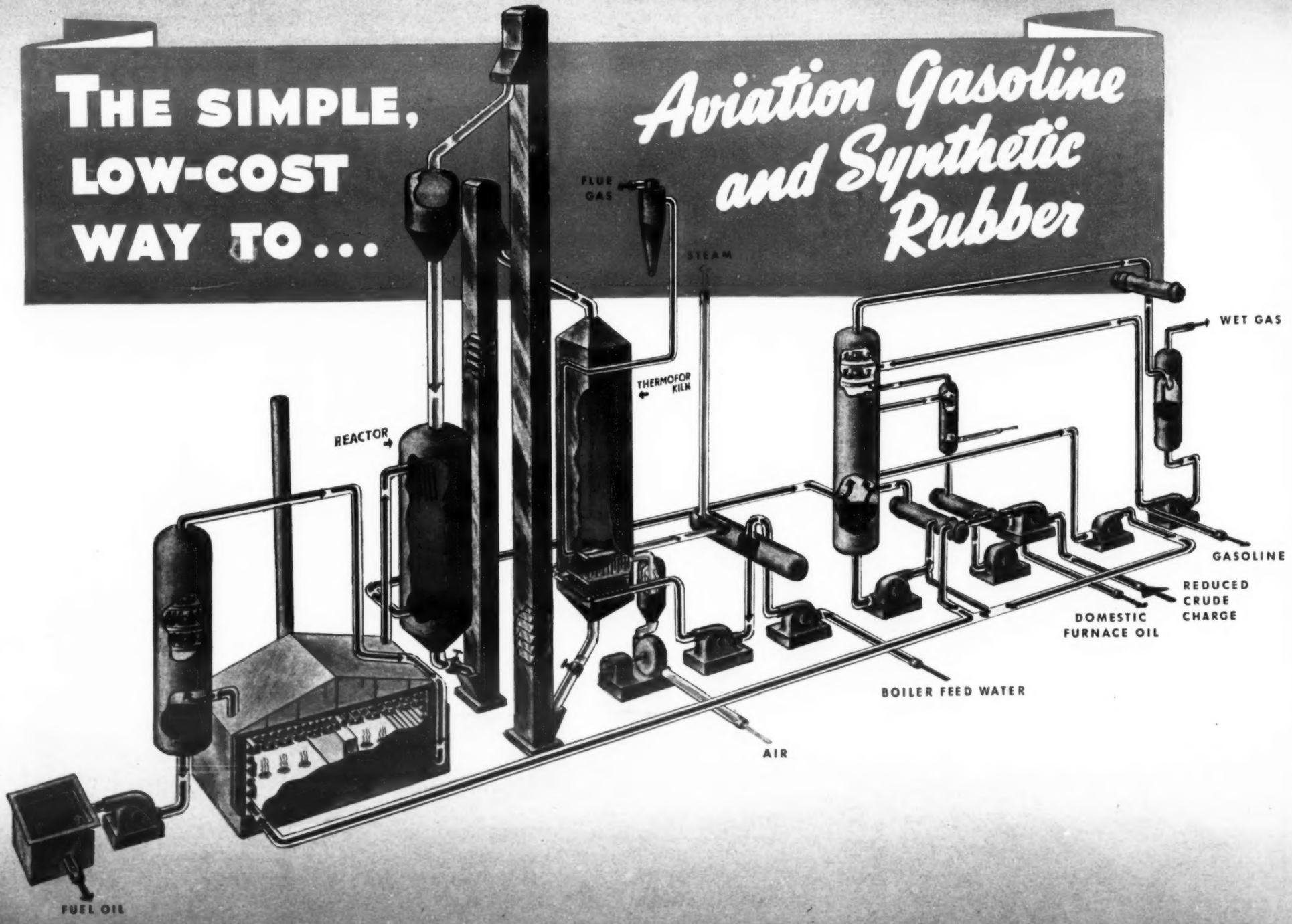
1412 MAURY STREET — **HOUSTON, TEXAS**

SALES OFFICES: Tulsa, Oklahoma; Dallas and Beaumont, Texas
LOS ANGELES: Western Pressure Control, 5700 Santa Fe Ave.
TRINIDAD, B.W.I.: Neal Massey Eng. Corp.

BRANCH STORES: TEXAS—Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi. LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS—Magnolia. MISSISSIPPI—Natchez.

THE SIMPLE, LOW-COST WAY TO...

Aviation Gasoline and Synthetic Rubber



THERMOFOR CATALYTIC CRACKING

The flow sheet on the preceding page indicates the simplicity, ease of operation, low investment cost and low operating cost of the Thermofor Catalytic Cracking Process. *

With T.C.C. Synthetic Bead Catalyst, the T.C.C. process gives

- 13% to 30% increased aviation gasoline yields over best present processes.
- 23% to 35% increased power output under optimum conditions over best present processes.
- 95-100 research octane number, 400 end point, 10 pound Reid vapor pressure motor gasoline with less than 3 c.c.'s of lead . . . by cracking gas oil once-through or recycling.

Furthermore, T.C.C. advantages can be secured in many cases with a saving of 50% in strategic materials through the conversion of existing thermal cracking or topping units. Less alloys are required in the handling of corrosive stocks.

THE LUMMUS COMPANY • 420 Lexington Avenue, New York 17, N. Y.
600 S. Michigan Ave., Chicago, Ill. • 634 S. Spring St., Los Angeles, Calif.
Mellie Esperson Building, Houston, Texas
70 Barn Hill, Wembley Park, Middlesex, England

*Licensed by Houdry Process Corporation

T. C. C. The War-Time process with the peace-time pay-off

LUMMUS

PETROLEUM REFINING PLANTS

DOWELL

RECONDITIONING SERVICES

WILL IMPROVE YOUR WELLS

Operators who find it necessary to improve their present wells are getting real results with Dowell selective acidizing and reconditioning services. Dowell has successfully reconditioned thousands of wells, and the experience thus gained proves conclusively that each well is an individual problem—there are no "rule of thumb" methods.

The Dowell Engineer and the Well Operator, by careful study of all available well information, can determine which of the many Dowell reconditioning services will secure the best possible results.

If more oil from present wells is your problem, let's get together. Dowell's eleven years' experience in this work, its competent engineering staff and a wealth of technical skill are all at your disposal.

DOWELL INCORPORATED
Executive Office: Midland, Michigan
General Office: KENNEDY BLDG., TULSA, OKLAHOMA
Subsidiary of The Dow Chemical Company

Dowell Services Available for Reconditioning

- Inhibited Acidizing
- Electric Pilot
- Plastic Plugging
- Acid Drilling
- Mud Acid
- Intensified Acid
- Low Surface Tension Acid
- Engineered Cementing
- Acid Jet Gun
- Paraffin Solvents
- Formation Cleaner

Look to

DOWELL

FOR OIL AND GAS WELL CHEMICAL SERVICE

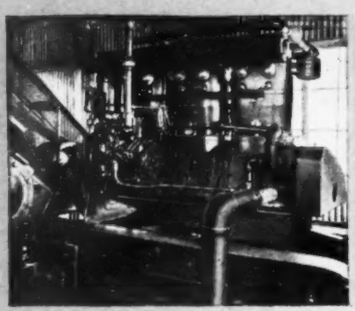
TAKE THE KINKS OUT OF YOUR

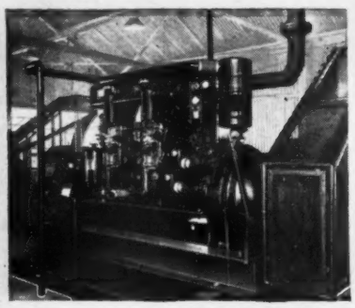
Pipe Line Power Problems

BY INSTALLING

Climax

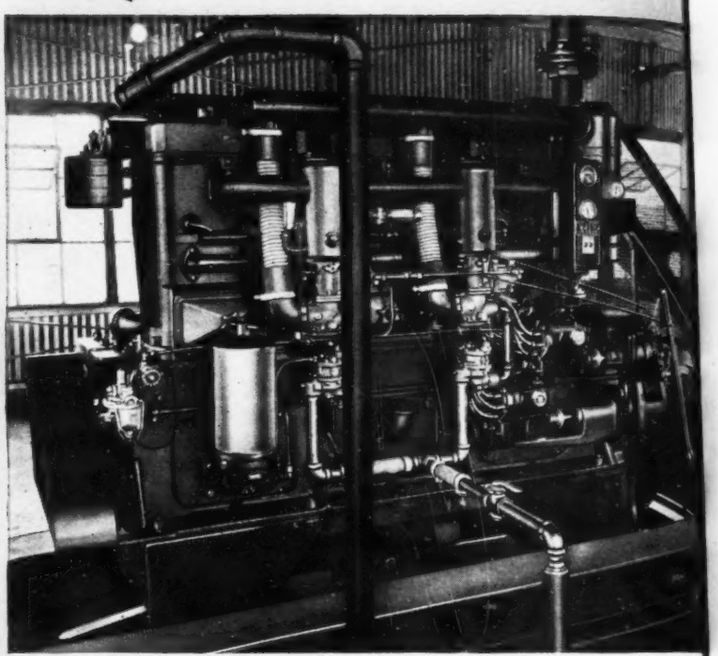
PIPE LINE PUMPING ENGINES





Climax Pipe Line Pumping Engines are a sound, long-term investment for driving pumps in pipe line stations.

Quick starting, dependable operation and negligible maintenance cost since installation are reported for these R6I Climax Engines used on the pipe line of an internationally known oil company.



THEY ARE QUICKLY INSTALLED—and furnished completely equipped for the particular requirements of the drive.

THEY GIVE UNFAILING OPERATION—The ability to run on a variety of fuels—natural gas, butane or gasoline—insures continuous operation. Dual ignition, two spark plugs per cylinder, provide highest power output and smooth effortless performance.

THEY STAND UP UNDER HEAVY CONTINUOUS LOADING — encountered in pipe line service.

THEY ARE EASY TO OPERATE AND MAINTAIN — Climax Engines are simply made, easy to run, and can be maintained by regular field mechanics without special training.

WRITE TODAY *to Climax Engineering Company, Clinton, Iowa, or to the distributors below for full details on engine types and sizes available.*

"For High Achievement in the Production of War Material"

ARMY NAVY

Climax Engineering Company

GENERAL OFFICES & FACTORY:
CLINTON, IOWA
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Distributed in the Mid-Continent by

THE CONTINENTAL SUPPLY COMPANY
General Offices: DALLAS, TEXAS

Distributed in the California Oil Field by

CLIMAX ENGINES & PARTS CO.
1406 S. Grand Avenue, Los Angeles, California

'TIL WE START THE *De La Vergne* DIESELS

Although reaching vast proportions, this country's outstanding and significant network of pipe lines would be utterly useless without the power needed to *make the oil flow*. Much of this power is supplied by hundreds of De La Vergne Diesels spotted at a like number of strategic points throughout the country. Consistent, economical and dependable De La Vergne Diesel engines have occupied a prominent place in the Petroleum field since 1907.

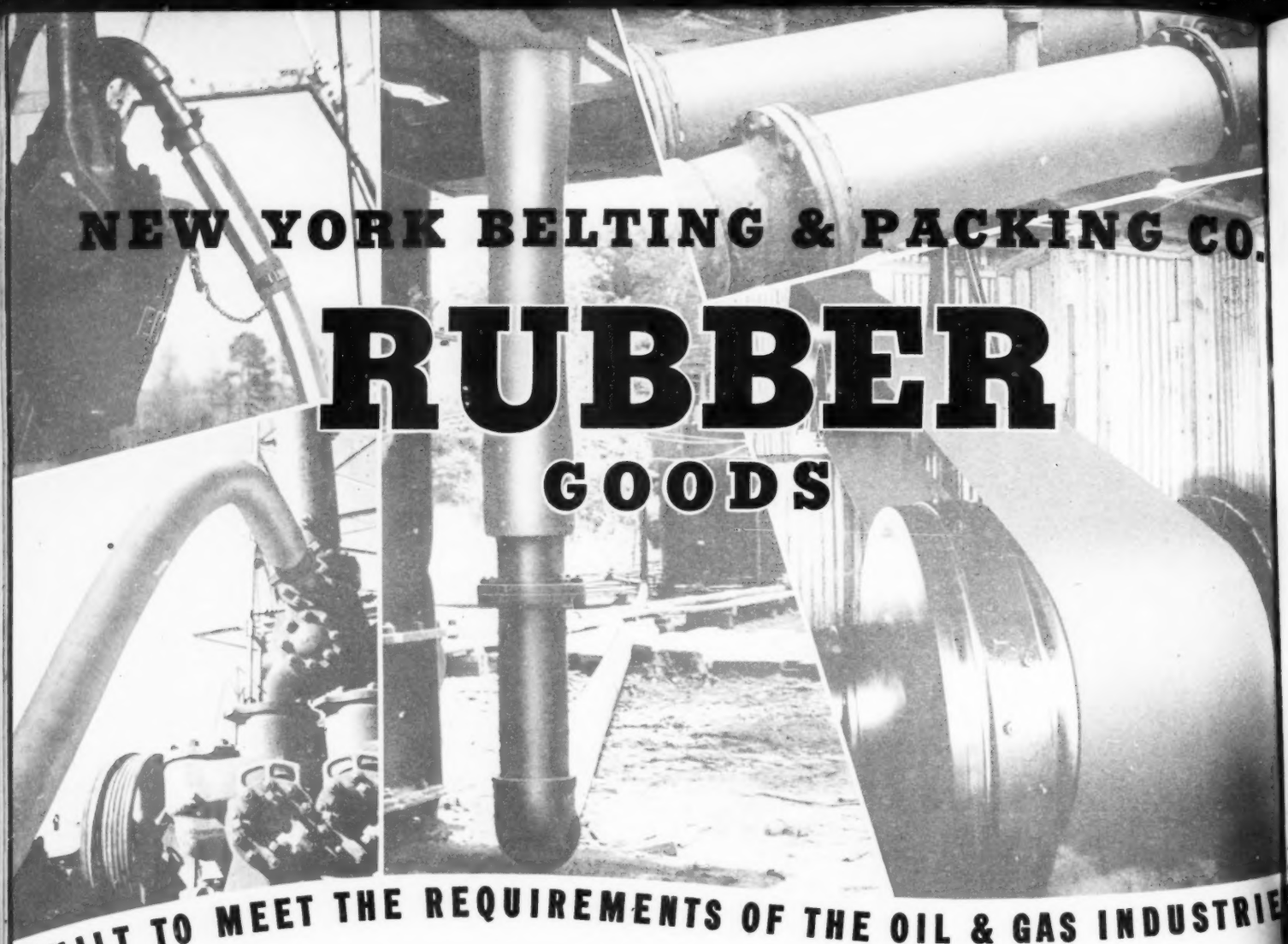
ARMY NAVY

BLW THE BALDWIN GROUP

BALDWIN DE LA VERGNE

SALES CORPORATION

SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS • PHILADELPHIA



NEW YORK BELTING & PACKING CO.

RUBBER GOODS

BUILT TO MEET THE REQUIREMENTS OF THE OIL & GAS INDUSTRIE

NEW YORK BELTING & PACKING CO. • Founded 1846

TODAY the spotlight is on synthetic rubber . . . more and more is being used in mechanical rubber goods—hose, belts, packings and other products used by the oil industry.

There are several basic types of synthetic rubber, each capable of innumerable variations in compounding. The right synthetic for one product may be entirely wrong for another. But N. Y. B. & P. Company has been using synthetic rubber in mechanical goods for 12 years—and has been studying its compounding and application for over 20 years. They have proved their ability to perform successfully and economically.

The Continental Supply Company is now distributing the rubber products of the N. Y. B. & P. Company. It is ready to serve the industries in their Drilling, Production, Pipe Line and Refinery requirements.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

EXPORT DIVISION

30 Rockefeller Plaza New York City, N. Y.

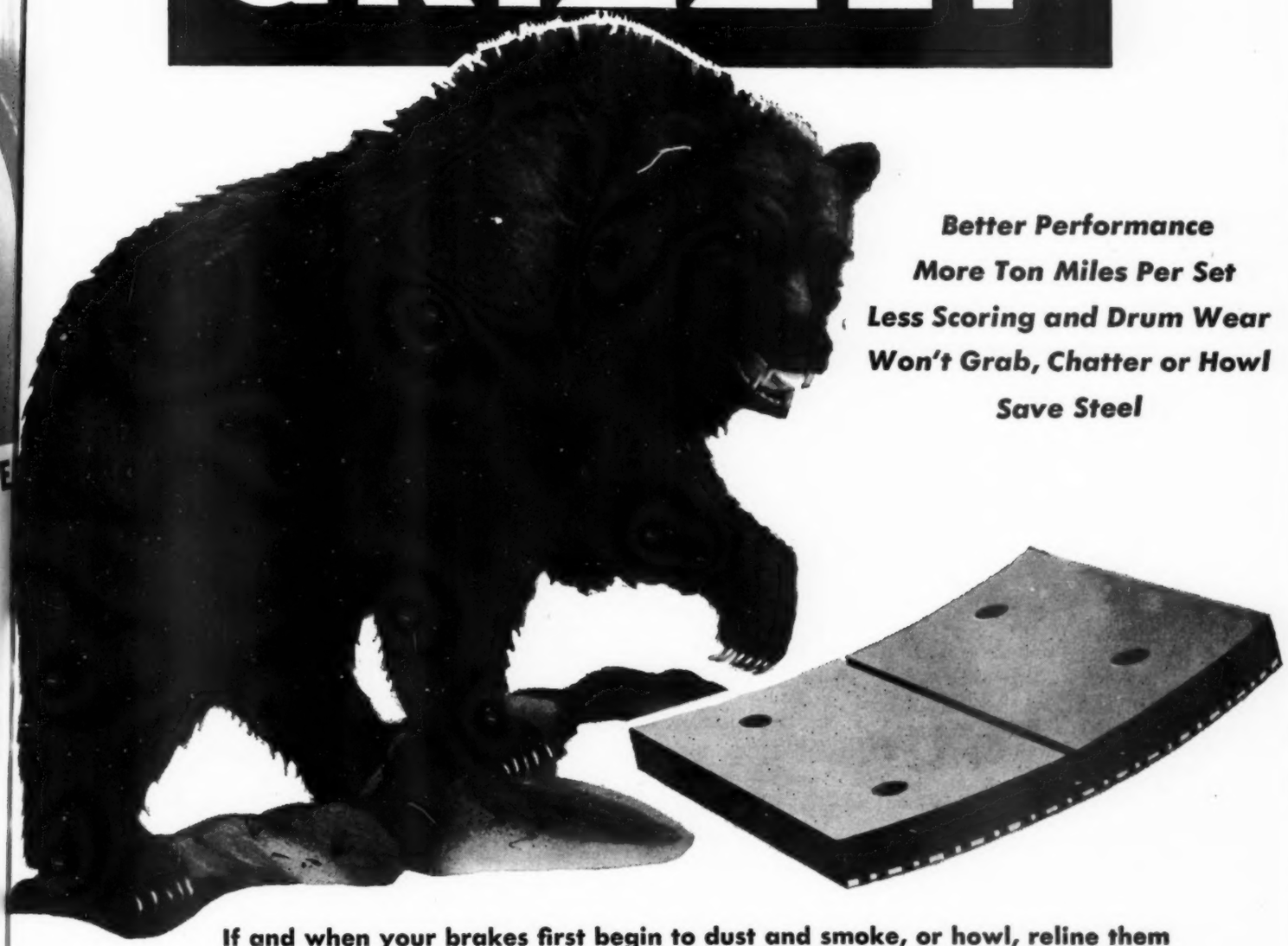
Representatives

MEXICO ARGENTINA ENGLAND TRINIDAD BRAZIL

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

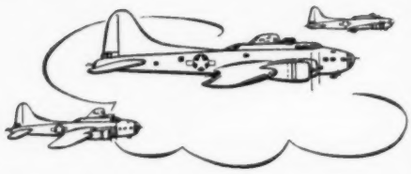
Reline WITH GRIZZLY



Better Performance
More Ton Miles Per Set
Less Scoring and Drum Wear
Won't Grab, Chatter or Howl
Save Steel

If and when your brakes first begin to dust and smoke, or howl, reline them with Grizzly Rotary Brake Blocks. For howling, dusting and smoking brakes are a warning of excessive wear and scoring of brake drums, *and avoidable waste of essential steel.* To insure perfect brake action and protect your valuable brake drums and bands, reline with Grizzly. Made to manufacturers exact specifications for all types of draw-works . . . Cardwell—Emsco—Franks—National (Ideal)—Oil Well—Wilson—and all other makes. Grizzly lined steel bands available.

GRIZZLY MANUFACTURING COMPANY
(Formerly E. M. Smith Company)
Manufacturing Plants at Los Angeles, California and Paulding, Ohio
Export Office: The Continental Supply Co. Inc., New York, N. Y.
Complete stocks maintained in our warehouses at: Houston, Texas - Oklahoma City, Okla. - Casper, Wyoming



LIFEBLOOD FOR FLYING HORSEPOWER

The Gauge with the "RECALIBRATOR"

Illustrated here is the Marsh Mastergauge, a gauge that brings new meaning to accuracy and stamina with its precision-built movement and bourdon tube bored from solid bar stock. That "Recalibrator" makes it the ideal gauge for today's needs, because it means that accuracy is locked in for keeps. If ever the gauge is knocked out of adjustment, a twist of the "Recalibrator" screw makes it accurate again at all points on the dial — something that has never been satisfactorily accomplished before.

★ Without gasoline to give life to their mighty horsepower, America's warplanes would be useless.

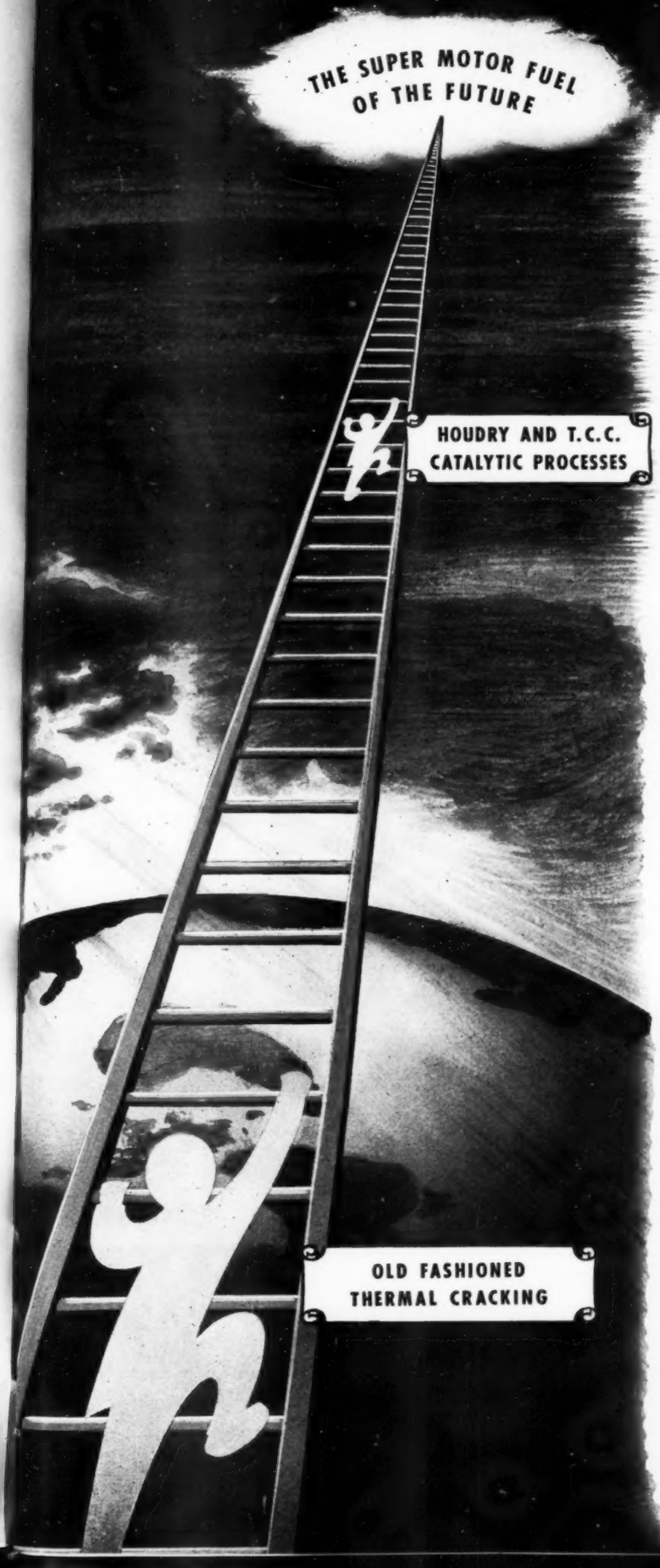
Fortunately the oil industry has developed the skill and technique to refine its products to the world's highest standards. Fortunately, too, all industry was ready to offer a helping hand by providing equipment and supplies to meet the oil industry's exacting requirements.

Marsh Gauges, for instance, are a part of the picture. Embodying all the refinements that Marsh has learned through 75 years of gauge-making, they offer a greater measure of accuracy and stamina that stands out under the stress of today's heavier responsibilities. To more and more operating men, the name Marsh has become the mark of "the oil industry's OWN gauge."

JAS. P. MARSH CORPORATION, 2097 Southport Avenue, Chicago 14, Illinois

MARSH GAUGES

THE SKY'S THE LIMIT FOR POST-WAR GASOLINE QUALITY



-but Houdry licensees *start* nearer the top!

One needs no gift of prophetic vision to foresee what is going to happen in the petroleum refining business after the war. The handwriting is in the sky. Tomorrow's super motor fuels, like today's 100-octane aviation fuel, will depend on *catalytic* cracking for their higher quality standards.

And 90% of *all* catalytically cracked aviation gasoline has been produced by Houdry processes. Seventeen Houdry units are now in operation—41 additional Houdry and T.C.C. units are in various stages of construction.

Much of this equipment has been financed by Houdry licensees out of their own pockets—a gratifying demonstration of their faith in the future. Thus, these companies will begin the post-war competition for motor fuel markets with a priceless advantage. They will have the equipment and the experience with which to produce gasoline far *better* than pre-war standards, far *cheaper* than by pre-war methods.

Largest licensor in the industry, based on refining capacity, Houdry offers not one but *three* catalytic cracking processes, each especially suited to certain types of refining operation and certain charging stocks. They are the Houdry Static Catalyst Process, Thermofor Catalytic Cracking Process and the Houdry Adiabatic Process. These three outstanding processes are available to all American refiners, under license arrangements, subject to approval by the United States Government.

HOUDRY CATALYTIC PROCESSES
... FOR VICTORY IN WAR ... FOR PROGRESS IN PEACE

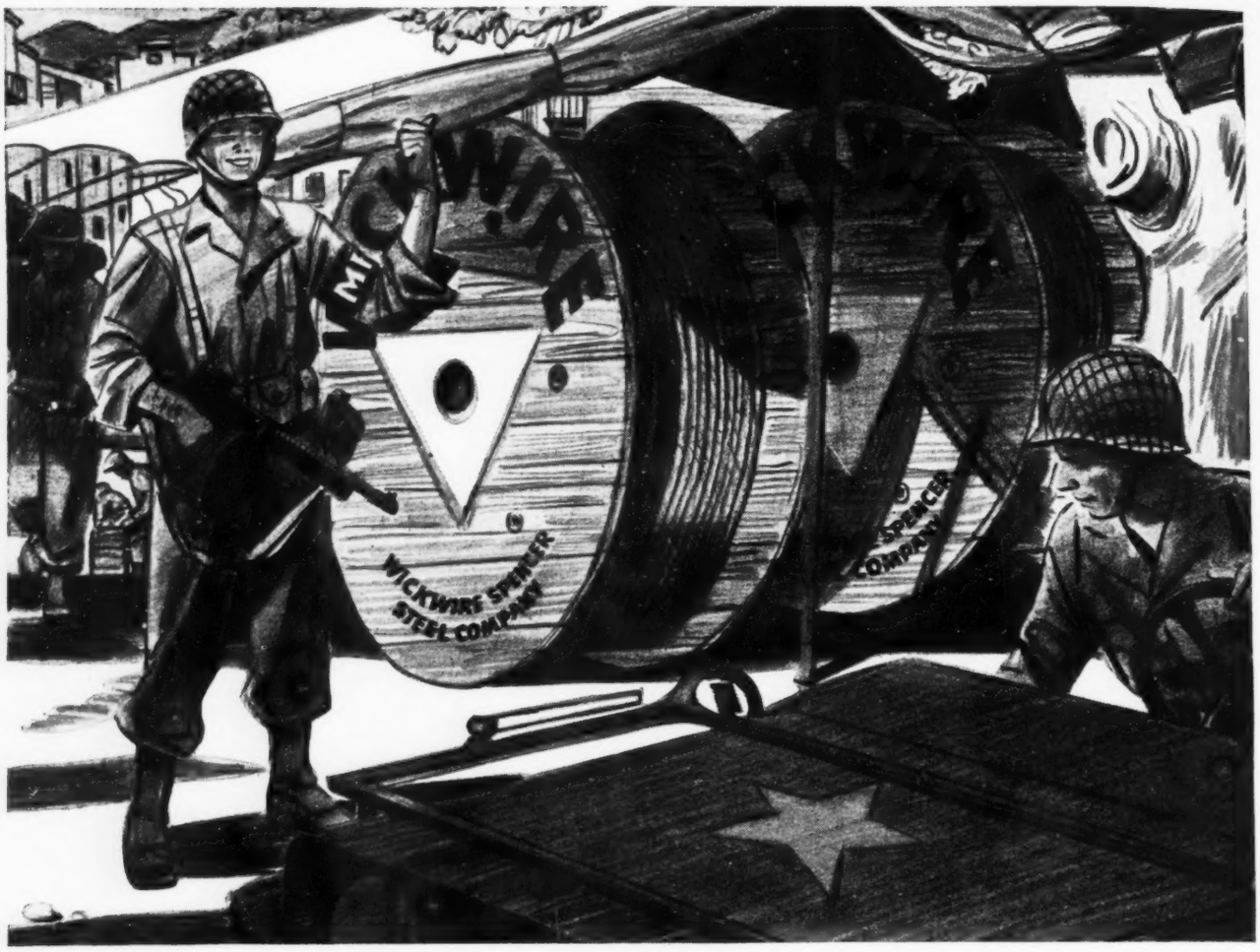
HOUDRY PROCESS CORPORATION
Wilmington, Delaware

Licensing Agents:

E. B. BADGER & SONS CO.
Boston, Massachusetts

THE LUMMUS COMPANY
New York City, New York

BECHTEL-McCONE-PARSONS CORP.
Los Angeles, California



"It's here to do a job, Pal—and soon!"

"We can't get along without plenty of that *friendly* wire rope. What does it do? Just stick around, soldier—and how do you think that souped-up bronco you're running around in got off the boat? Wire Rope!"

The guard is right. It takes a lot of easy-handling wire rope to move the stuff an Army needs. Think of North Africa—think of Sicily! And there has to be *enough* of it!

That's why you and we at home here have to conserve the wire rope *we* use.

But when you do need to order replacements, won't you please accept it *without* reels, if lengths permit, so that handier reels can be spared for the boys out there? Wickwire Spencer Steel Company, 500 Fifth Avenue, New York 18, N. Y.

• • •

Wickwire Spencer, the first in New England to be awarded the Maritime M and Victory Fleet Flag, has now received the GOLD STAR for maintaining excellence of production.

DO YOUR MEN KNOW PROPER SHEAVE DIAMETERS?

Our FREE book, "Know Your Ropes," will tell them. It tells why a sheave that is too small wears out rope fast. It shows how to figure the right size sheave for every diameter of rope . . . and gives numerous other "Life Savers" that will help make your present wire rope last longer. Send for your free copy, today!

SEND YOUR WIRE ROPE QUESTIONS TO WICKWIRE SPENCER

WICKWIRE ROPE

Sales Offices and Warehouses: Worcester, New York, Chicago, Buffalo, San Francisco, Los Angeles, Tulsa, Chattanooga, Houston, Abilene, Texas, Seattle. Export Sales Department: New York City

WISSCO PRODUCTS

"PIPING POINTERS"

A SERVICE TO INDUSTRY AT WAR

Helps Train Piping Crews
Helps Conserve Critical Metals
Helps Speed Piping Installations
Helps Keep Pipe Lines Flowing
Helps Get Longer Life from Piping Equipment

As industrial manpower and equipment supplies grow more critical, more and more plants are realizing the usefulness of "Piping Pointers" Bulletins in coping with maintenance problems. Listed above are five major helps these bulletins are giving. Users say there's no end of ways in which this Crane service is helping piping men, both trainees and veterans, do a better job of keeping piping on the job.

Every hint in "Piping Pointers" is sound, practical, authentic. They're based on 88 years of flow control engineering by Crane—world's leading maker of valves and fittings.

HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
Short-Cuts to Faster Piping Jobs
TIPS ON VALVE TRIM
How to Repair Valves

Watch for announcement of "Piping Pointers" sound film now in the making. Ready soon for use in your plant.

FREE TO ANY PLANT

One of its emergency services to industry, Crane offers a supply of "Piping Pointer" Bulletins to any plant requesting them. No obligation. Ask your Crane Representative, or address Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.

CRANE VALVES

this man does a Better Job because——

He is proud to call a "spot" in the United States his home, grateful that he and his family enjoy the Four Freedoms, and determined that those who are carrying the fight to the Axis shall not suffer for want of fighting materials.

Even in war production centers, where new workers have come to make the tools of war, thousands of them have found their homes in new "STURDYBILT" prefabricated houses.

The acceptance of "STURDYBILT" by the oil industry, since the first house was built in 1919, and the development made possible by meeting the requirements for oil field housing has enabled Southern Mill to be ready with "enough at the right time."

"STURDYBILT" prefabricated sectional houses are available to fill "war-time" housing needs in any industry. Our housing engineers will be glad to advise and work with you on your present or future housing requirements.

No "STURDYBILT" house need become untenantable, prefabricated sections are available for repairs or reconditioning.

SOUTHERN MILL & MANUFACTURING CO.

Wichita, Kansas **TULSA, OKLAHOMA** Longview, Texas

Use Carbon Graphite and Karbate Products

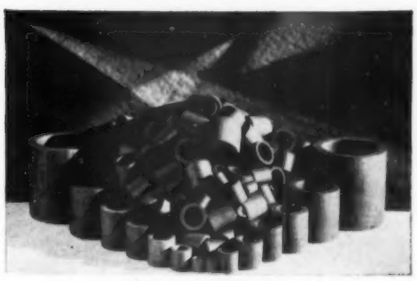
.TRADE-MARK

FOR HANDLING

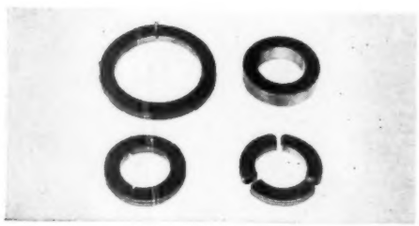
- HYDROFLUORIC ACID
- HYDROCHLORIC ACID
- SULPHURIC ACID

IN
- ✓ Acid Manufacture.
- ✓ Recovery of Acid.
- ✓ Catalyst Regeneration in Hydrogenation, Alkylation, and Polymerization Processes.
- ✓ Caustic removal of Hydrogen Sulphide for which Carbon Raschig Rings have long been preferred.

"National" and "Karbate" carbon and graphite materials possess the following important characteristics. Consider these characteristics when designing new equipment or when seeking greater economy and efficiency from existing equipment.



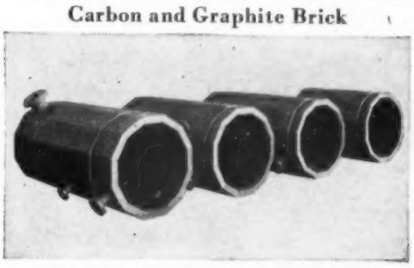
Raschig Rings



Packing and Seal Rings

Carbon and Graphite Brick

Tube and Shell Heat Exchanger



Sections for Segmental Tower

- Resistance to severe corrosion
- Ability to withstand extreme thermal shock
- Light weight
- High thermal conductivity for heat exchange or dissipation (graphite and graphite base "Karbate" units)
- Low thermal conductivity for conveying with minimum of heat loss (carbon and carbon base "Karbate" units)
- Good mechanical strength
- Ease of machining and fabrication
- Availability in a large variety of forms and sizes.

Write for descriptive bulletin CS-M-8800A. Our engineering staff will be glad to assist you on any problems involving the use of carbon and graphite materials.

The words "National" and "Karbate" are trademarks of National Carbon Company, Inc.

Pipe, Fittings, Bubble Caps and Trays

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

CARBON PRODUCTS DIVISION, CLEVELAND, OHIO

General Offices: 30 East 42nd St., New York, N. Y.

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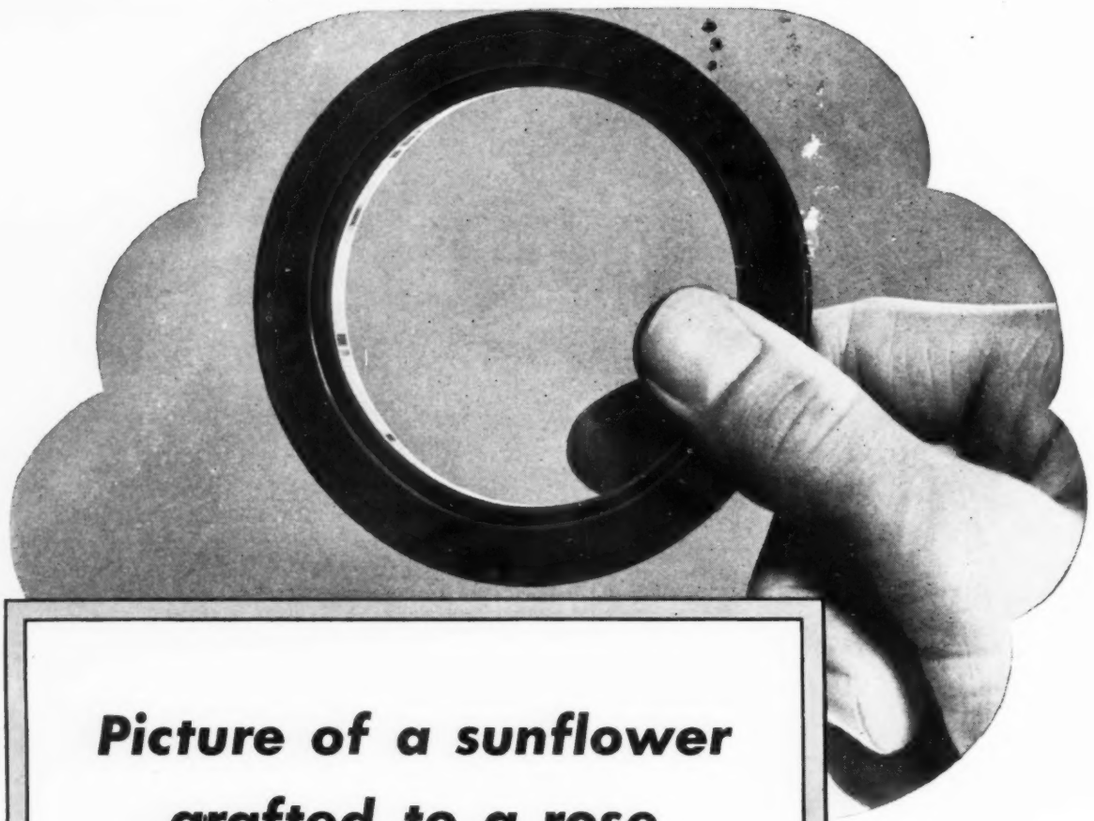


Picture of a sunflower grafted to a rose

ILLUSTRATED here is a metal-insert hydraulic seal for aircraft use. The metal was carefully and precisely machined to extremely close tolerances.

But whatever was gained by accurate machining was promptly thrown away, for they bonded to it a resilient material that swells as much as 10% or 15% in hydraulic oil.

It's like grafting a sunflower to a rose.

For fine, close-tolerance performance in resilient materials, engineers in vital war industries are specifying Hycar synthetic rubbers. Why? Because Hycar can be tailored to the job. Oil-swell can be limited to plus or minus 1%, or even held to zero. In addition, Hycar can withstand temperatures of 250°, abrasion resistance is 50% in excess of natural rubber, and compression-set characteristics are excellent.

Aren't these the qualities you have wanted in cargo and fuel hose, gaskets, seals, packers, diaphragms and other products you use? *Hycar Chemical Company, Akron, Ohio.*

Hycar is supplied in crude form to rubber fabricators. Because of its outstanding performance in war uses the demand far exceeds the supply. But now is the time to work out with your supplier of rubber products ways of obtaining Hycar for actual test in your own applications, both present and future. It's to your advantage to gain experience now against the day you will need new and even better rubber products. Our technical staff and laboratory are ready to help.

Hycar

LARGEST INDEPENDENT PRODUCER OF BUTADIENE SYNTHETIC RUBBER IN AMERICA

QUALITY
TRADE MARK
YOUNGSTOWN
SERVICE

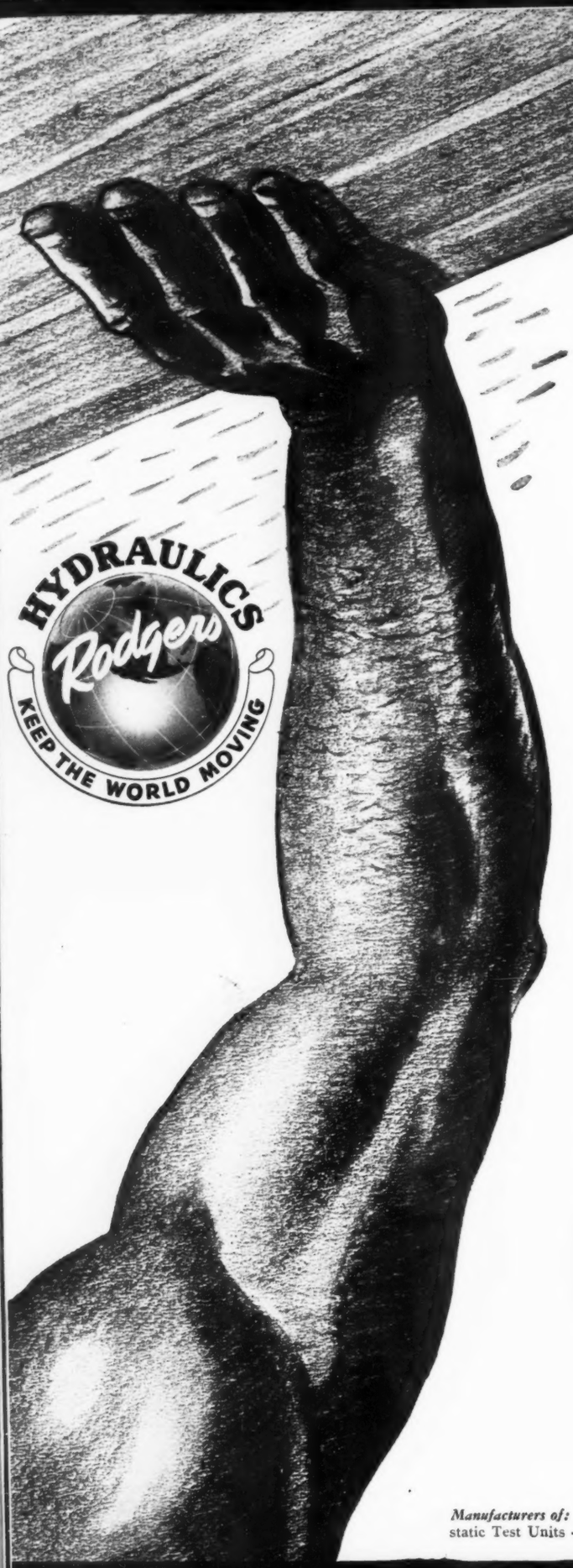
40 Years of Quality

FOR 40 years Youngstown has produced casing, tubing, drill pipe and line pipe for the oil industry. [illegible] unsurpassed quality in all of the world's fields where men have drilled [illegible]

combined with most modern production facilities have kept the name YOUNGSTOWN synonymous with highest quality.

Look for the orange bands . . . they identify oil country tubular goods as Youngstown and assure dependable performance in every feature by which these products are judged.

SHEET AND TUBE COMPANY, *Youngstown, Ohio*
Manufacturers of
CARBON · ALLOY AND YOLOY STEELS
Pipe and Tubular Products ... Sheets ... Plates ... Conduit ... Bars ...
Tin Plate ... Rods ... Wire ... Nails ... Tie Plates and Spikes

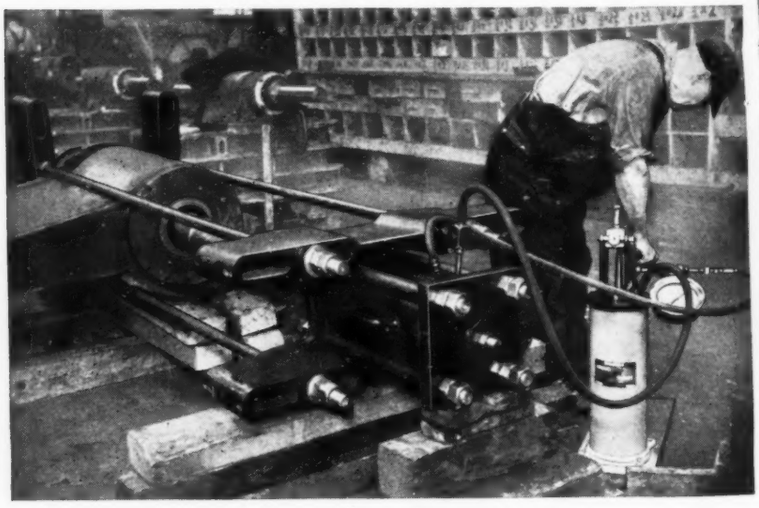


200 TONS PRESSURE!

Rodgers Universal Hydraulic Presses have been purchased by many large industrial shops equipped with large stationary presses. Engineers and shop superintendents recognize the advantage of having a powerful portable press to take to the repair job.

Ask your mechanic what he thinks of press equipment that can be used in any place and in any position where pulling, pressing or lifting power is needed. The Universal Press is portable and can be carried to the job and assembled around the work.

Illustrated below is a 200-ton unit, removing bearings and sleeves from pitman of a Diamond Iron Works Crusher, the job requiring 237 tons pressure. ***If it's a Rodgers, it's the best in Hydraulics.*** Rodgers Hydraulic Inc., St. Louis Park, Minneapolis, Minnesota.



Manufacturers of: Universal Hydraulic Presses - Track Press Equipment - Hydraulic Keel Benders - Hydrostatic Test Units - Power Track Wrenches - Hydraulic Plastic Presses - Portable Straightener for Pipe and Kellys

Rodgers HYDRAULIC Inc.

YOU DON'T NEED A WATER TANK OR TOWER

- Jacket Water
- Natural Gas
- Compressed Air
- Steam Condensing
- Hydro-Carbon Vapor
- Lubricating Oil

Racine, Wis.

YOUNG-HAPPY COOLERS ARE THE IMPROVED COOLING METHOD

Installation costs are reduced because this cooler is a small compact unit and can be quickly installed. Important savings are also made since there is *no* need for costly water systems.

Engineered and built for years of service, you get better cooling with this full flow, compact Young-Happy unit.

Keeps engines operating at most efficient temperature summer or winter . . . Prevents excessive ring and piston wear. . . Prevents scale formation in Jacket. Bring your cooling problems to our engineering department.

OTHER HAPPY PRODUCTS

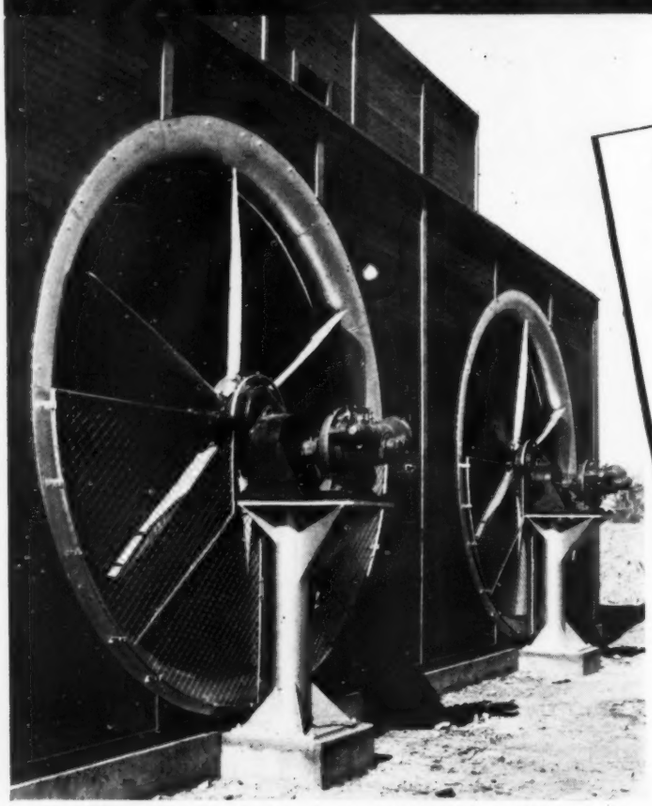
- Happy Chain-driven Pumping Units
- Endless Flat Belts
- V-Belts
- V-Belt Sheaves
- Power Transmission Equipment

The Happy Company
TULSA, OKLAHOMA

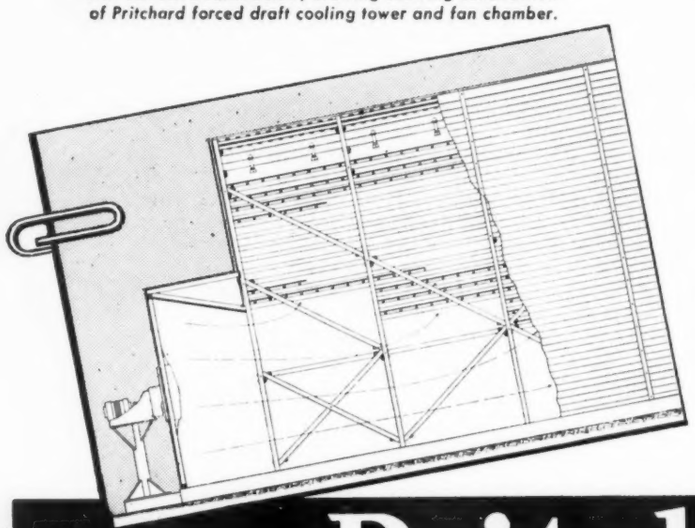
"Chases Heat"

Representatives and Branches: Seminole, Oklahoma City, Oklahoma; Smackover, Arkansas; Odessa, Kilgore, Pampa, Texas; Salem, Illinois; Wichita and Ellinwood, Kansas.

LOW COST COOLING
FOR A LONGER PERIOD OF TIME



View of fan chamber housing two Pritchard light weight non-corrosive fans. Below, drawing showing construction of Pritchard forced draft cooling tower and fan chamber.



Pritchard
COOLING TOWERS
- **Cost Less to Operate**
- **Increase Cooling Efficiency**
- **Prolong Service Life**

SPREAD your cooling costs over a period of five years and you will readily see how PRITCHARD TOWERS give you *low cost cooling.*

Low pumping heads, large pipes and low pressure sprinklers keep power costs down. Counter flow design provides cool dry air to contact coldest water, thus producing lowest possible temperature and increasing cooling efficiency.

Non-corrosive, light weight, wide blade fans move up to 400,000 cubic feet per minute using less power, which further reduces operating costs. Being non-corrosive, fan blades will not pit, thus cost less to maintain and give greater efficiency.

PRITCHARD TOWERS are designed with that extra margin of structural safety that not only withstands ordinary load stresses, but prolongs service life.

Delivery of PRITCHARD COOLING TOWERS is facilitated through standardized sectional construction. A complete line of stock is maintained at all times, ready for immediate shipment.

J. F. Pritchard and Company, *Cooling Tower Division,* Fidelity Building, Kansas City, Mo.

KANSAS CITY
TULSA
CHICAGO

Pritchard

HOUSTON
NEW YORK
PITTSBURGH

ENGINEERS AND CONSTRUCTORS
FOR THE CHEMICAL • PETROLEUM • GAS AND POWER INDUSTRIES
Manufacturers of Mechanical and Atmospheric Cooling Towers

CONTINUE TO "GUARD THOSE VALVES"

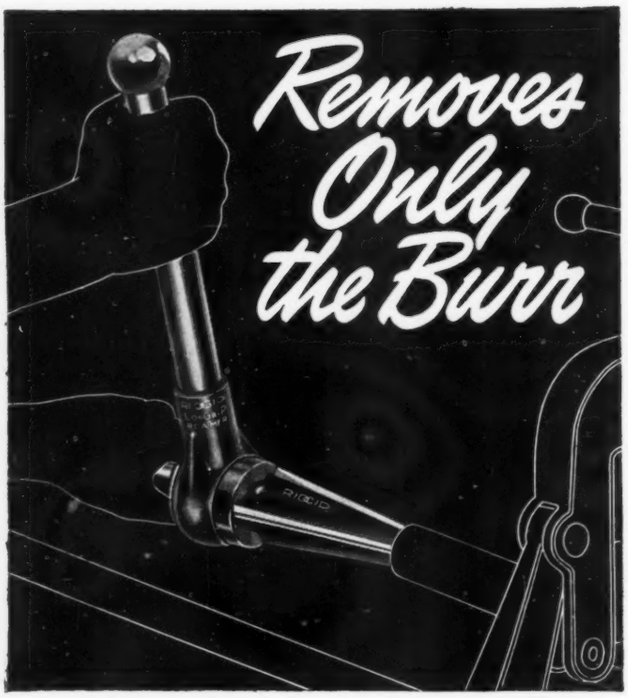
Since such tremendous tonnage must be carried to forces around the globe, it is easy to understand why Reading-Pratt & Cady for so long have advised you to "guard those valves." Ships are a maze of valves. ★ Strides toward victory should not encourage the thought that the transport of matériel for fighting Americans be put in jeopardy—so that we at home might have more. Now is the time to put into war every ounce of drive we can muster. Continue to guard your valves.

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, Portland

A DIVISION OF **AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT, CONNECTICUT**

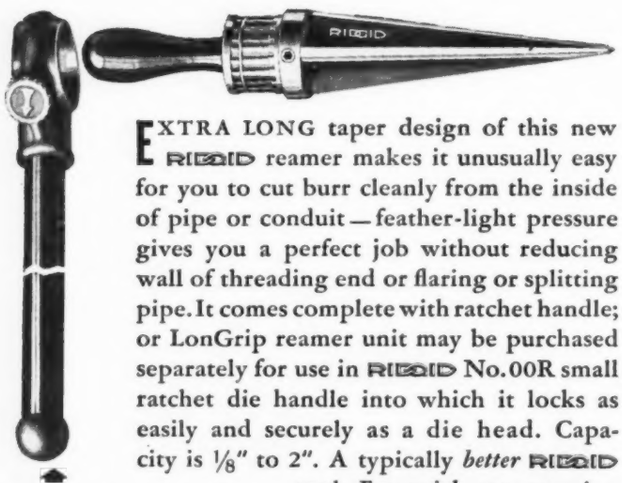


Work-saver RIDGID is your defense against pipe wrench breakdown

THE unique advantage of this RIDGID wrench becomes more valuable the further around the fighting globe it goes from sources of replacement and repair. For that guaranteed housing means it won't break or warp, it keeps on working! No binding of hookjaw or of adjusting nut in its wide open housing. But you haven't any more time to repair wrenches these days than the fighting services have. For delay-proof tools today and money-saving tomorrow . . . ask your Supply House for the RIDGID.

Same failure-proof RIDGID quality in this End Pattern for hard-to-get-at pipes in coils or against flat surfaces. Sizes 6" to 36".

New RIDGID Extra-Long-Tapered Reamer



EXTRA LONG taper design of this new RIDGID reamer makes it unusually easy for you to cut burr cleanly from the inside of pipe or conduit — feather-light pressure gives you a perfect job without reducing wall of threading end or flaring or splitting pipe. It comes complete with ratchet handle; or LonGrip reamer unit may be purchased separately for use in RIDGID No. 00R small ratchet die handle into which it locks as easily and securely as a die head. Capacity is 1/8" to 2". A typically *better* RIDGID tool. For quick easy reaming without risk of damaging the pipe, ask your Supply House today for this new *extra-long-taper* LonGrip Reamer.

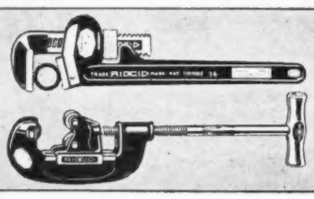
If you already have a RIDGID No. 00R Ratchet Threader all you need to buy is the LonGrip Reamer unit — it works perfectly in the 00R ratchet handle.

Buy RIDGID Pipe Tools at Supply Houses Everywhere

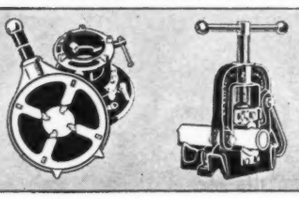
RIDGID

★ PIPE TOOLS ★

THE RIDGE TOOL COMPANY
ELYRIA, OHIO, U.S.A.



Fast-Working Tools for War . . . and the Busy Peace that's Coming

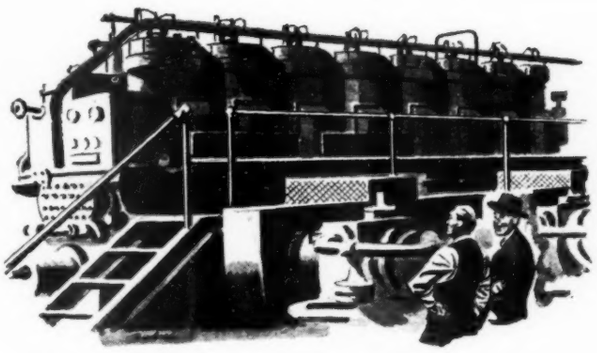


These Koppers products help

stop absenteeism

in production equipment

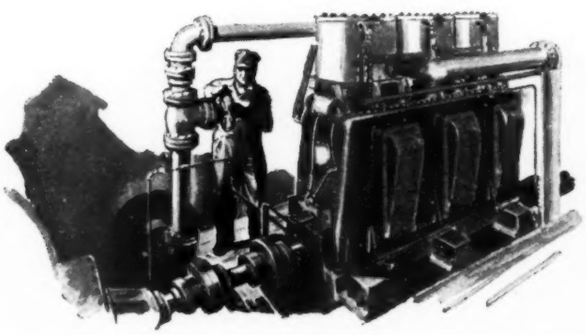
Piston Rings



War put old compressor equipment on an overtime basis, multiplied demands on new machinery. American Hammered Piston Rings had and have the *extra* service-factor that meets these needs. A combination of research, and skilled engineering and production, has kept them a year ahead.

This capacity for service above and beyond line of duty comes from 25 years of foundry, shop, inspection and engineering experience in solving tough ring problems. Where the last ounce of effort is essential, you'll generally find American Hammered Piston Rings on the job.

Fast's Couplings



Bombing raids burn plenty oil . . . and the petroleum industry must keep it flowing to keep 'em flying. Fast's Couplings are helping on drilling rigs, in pumping stations and in refineries. Experienced engineers have known for years that installing "Fast's" is the best way to avoid operating troubles.

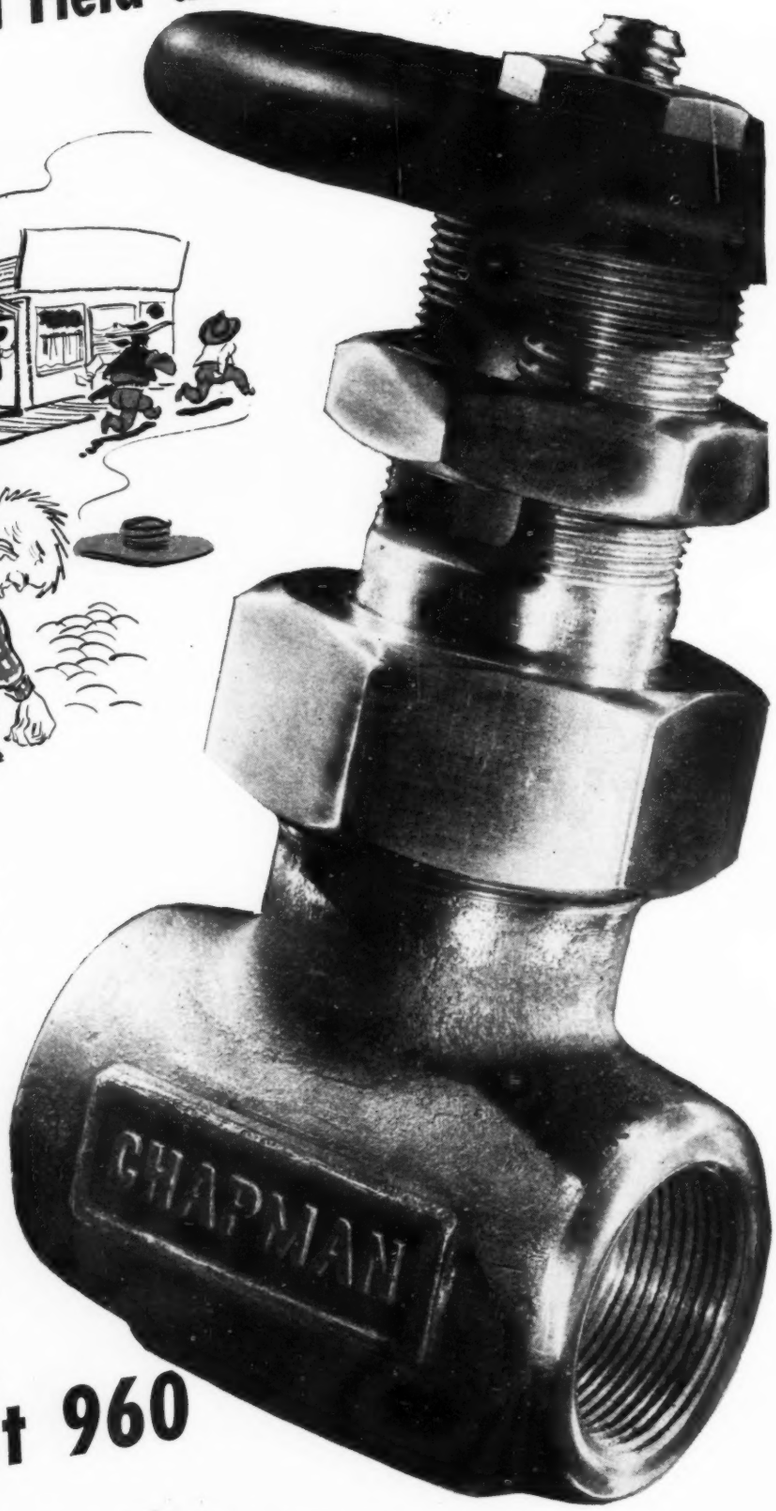
Fast's Couplings have no perishable parts. The load carrying surfaces are protected against wear by a positive film of oil. This oil is kept permanently clean by rocking bearings, which make precise metal-to-metal contact, and are in the one position to form a dust and moisture-proof seal.

Koppers Company and Affiliates, Pittsburgh, Pa.

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

Here's Your Keeper of Law and Order on Small Field and Refinery Lines



All the usual small-valve troubles hit for the tall timber when Chapman List 960 takes over on lines from ¼" to 2". Wear is kept under strict restraint by tough steel plugs and seats . . . which may even be super-hardened by an exclusive Chapman process, if your service is out of the ordinary. And there's never any balking in operation, for the quick-acting threads can't stick, strip or jam. As for repacking, that's easily done under full pressure with the valve open. Chapman List 960 is okay for all pressures up to 800 lb. at 750° F., and up to 1500 lb. cold working pressure. Standardize on List 960 . . . and there will be no "disturbance of the peace" on *your* lines.

The CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASS.

CHAPMAN List 960
Subdues all Small-Valve Troubles

If you want your wire rope to last
DON'T FORGET LUBRICATION!

LACK of proper lubrication is one of the most frequent causes of premature wire rope failure. Yet lubrication is such a simple means of extending rope life that it seems incredible that rope users ever overlook it. But they do.

Every U·S·S American Tiger Brand Wire Rope comes to you from the factory, properly lubricated and ready for service. But factory lubrication, no matter how efficient, will not last the life of the rope. Field lubrication at regular intervals is absolutely essential. Wire Rope is a machine, composed of many working parts. It requires lubrication to reduce frictional wear.

Use a well-tested lubricant like Tiger-Lube which has been developed through years of study and research. Be sure that the rope surface is clean and that the lubricant is applied uniformly and thoroughly.

Lubrication is insurance against corrosion and is the safest way to prevent excessive internal and external rope wear. Lubrication will materially assist in controlling the wear on sheaves and drums and in prolonging rope life, resulting in increased operating efficiency.

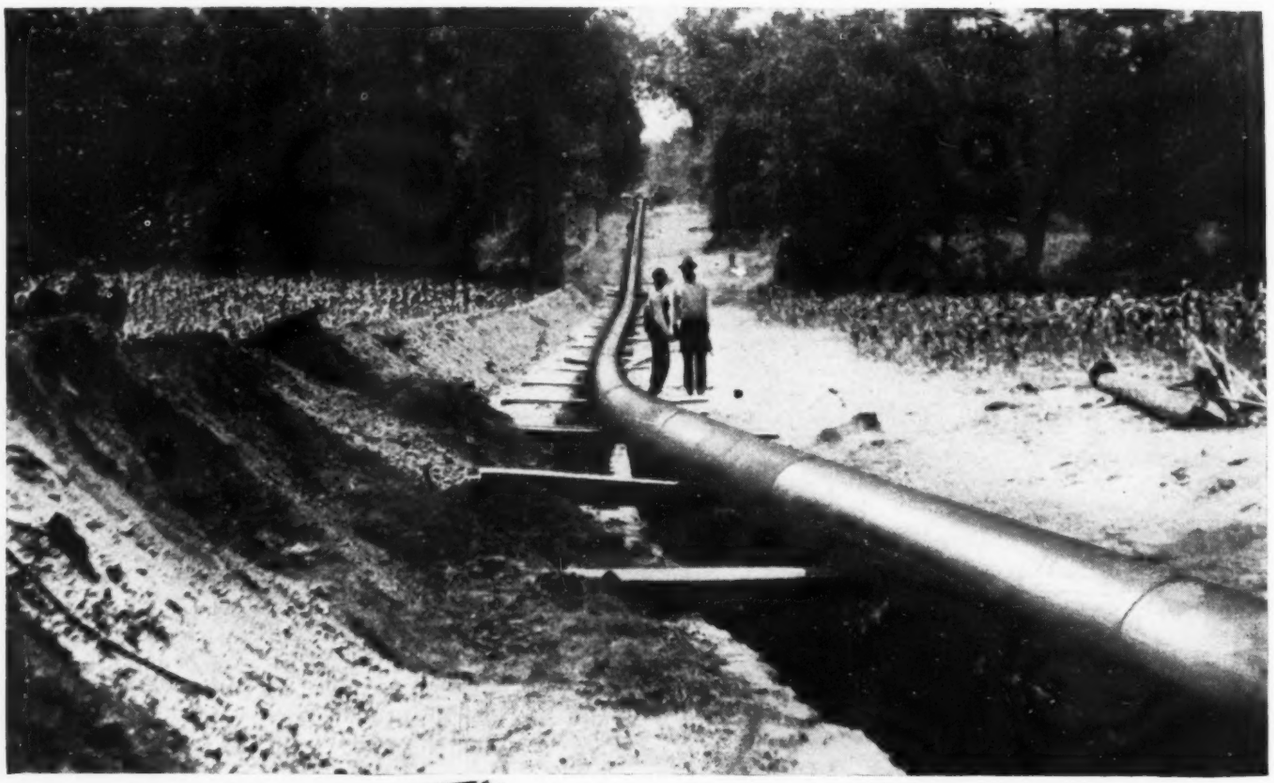
SEND FOR THIS BOOK
—IT'S FREE!

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York

Excellay Preformed

UNITED STATES STEEL

PARSONS



For extra wide trenches, not too deep, dual booms may be effectively used.

For Speed in Digging Pipe Line Trenches

Trees, Poles, steep banks and other obstructions won't halt your pipe line digging when you are using a Parsons Trencher with the shiftable offset boom. Excavations may be made with boom in extreme right or left hand position, without sacrifice of speed or ease of operation. With a Parsons you can dig within 14 inches of a side obstruction, and on line with outside edge of either crawler. This one Parsons feature alone will save hours of digging time.

For complete details write The Parsons Company, Newton, Iowa

TRENCHING EQUIPMENT PARSONS

HOW PETRECO DESALTING *Protects* A REFINERY TOPPING SECTION

EXCHANGER PLUGGING

Exchanger plugging due to salt reduces throughput and often causes over-loading of the pipe-still heater. Lost on-stream time is the inevitable and costly result. Petreco High-Efficiency Desalting prevents salt plugging.

CORROSION AND COKING OF FURNACE TUBES

Corrosion and coking of furnace tubes result from charging salty crude. These troubles often lead to blistered and plugged tubes. The ultimate result is costly down-time for clean-out; tube replacements.

CORROSION—UPPER SECTION OF BUBBLE TOWER

Corrosion in the upper section of the bubble tower, resulting from acids evolved from salt in the crude, can be materially reduced by efficient Petreco Desalting.

SALT DEPOSITION ON BUBBLE TOWER TRAYS

Bubble tower tray plugging is due to an excess of salt in the crude. Petreco Desalting prevents this frequent cause of inability to meet product specifications.

The Topping Section is just one phase of refinery operations that can be bettered by charging comparatively salt-free crudes. Petreco Engineers can show you many specific examples of improved performance because of high-efficiency desalting. The facts are available without cost or obligation to you. Why not get them?

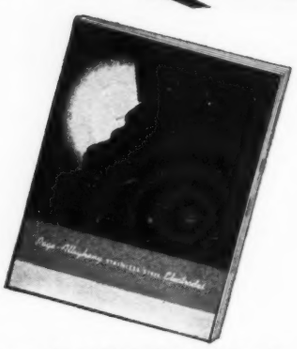
PETROLEUM RECTIFYING COMPANY

P. O. Box 2546, Houston 1, Texas
648 Edison Building, Toledo 4, Ohio
530 W. Sixth St., Los Angeles 14, Calif.
Representatives in all principal fields and refining centers.

IN WELDING "STAINLESS"

IT IS ABSOLUTELY ESSENTIAL THAT THE ELECTRODE YOU USE GIVES A DEPOSIT THAT EQUALS THE STAINLESS STEEL THAT YOU ARE WELDING

You can depend on always being able to select the correct electrode from the complete line of **PAGE-*Allegheny* STAINLESS STEEL ELECTRODES**—each of which has been developed and tested in close collaboration with the world's largest tonnage producers of Stainless Steel.



Ask your local PAGE Distributor for a copy of the well illustrated booklet that gives complete instructions on the selection of the correct Stainless Steel Electrodes for the Stainless Steel you are welding.

PAGE
WELDING ELECTRODES

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AMERICAN CHAIN & CABLE COMPANY, Inc.

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OIC Cast Steel Valves . . . Gates . . . Globes . . . Angles . . . Checks . . . are ready and qualified to do just the job you need done.
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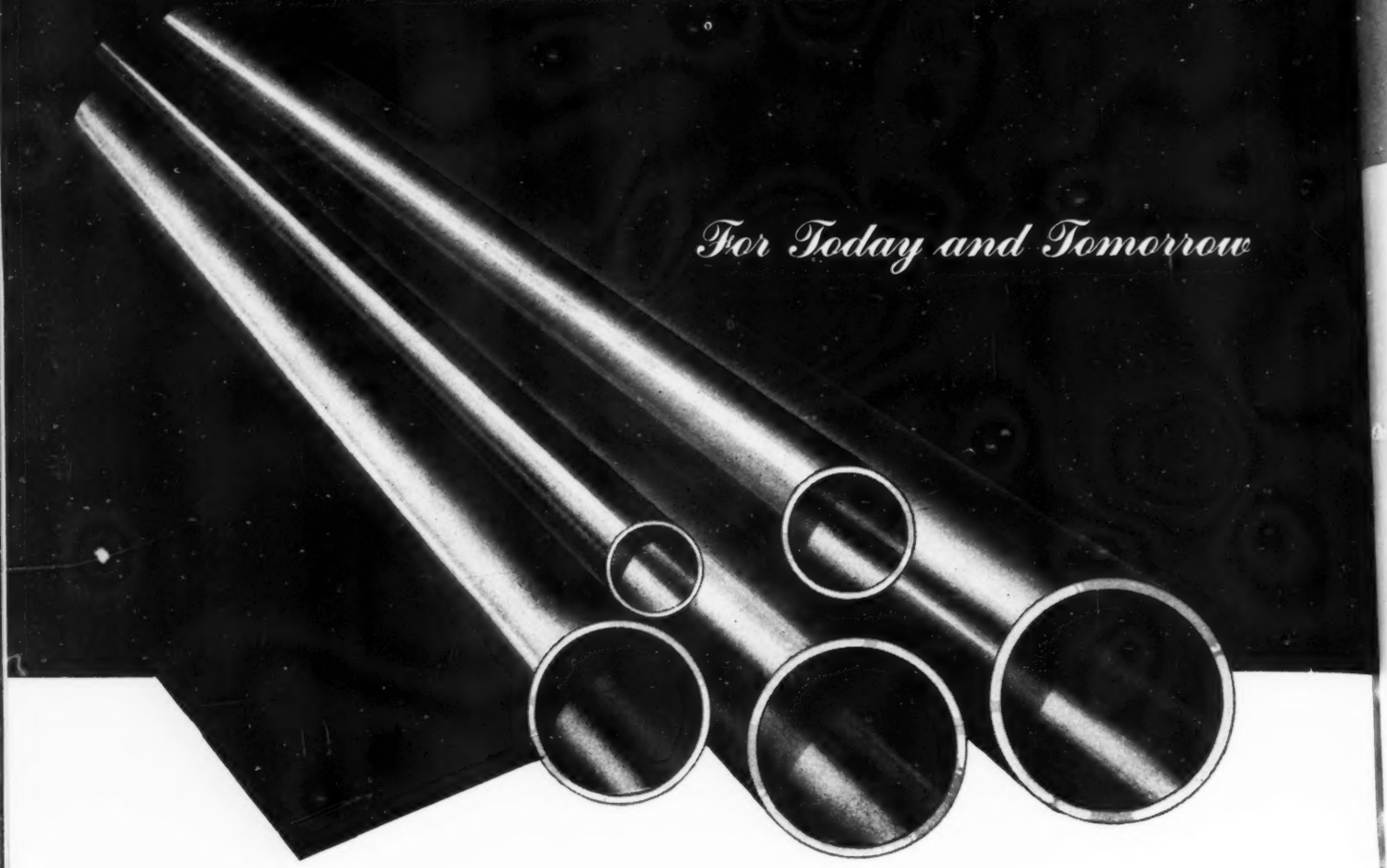
BETTER ELECTRIC WELDED STEEL TUBING

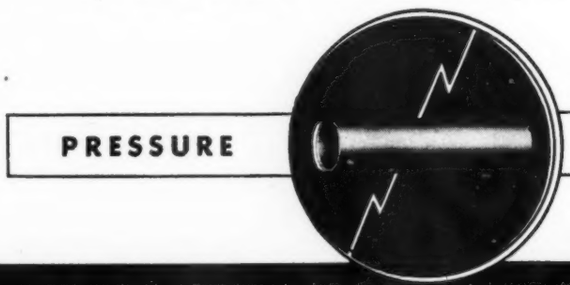
For Today and Tomorrow



PRODUCED ON AMERICA'S MOST MODERN TUBE MILLS

For your wartime applications requiring greater strength and lighter weight, Talon's Electric Welded Steel Tubing is being produced in ever increasing quantities. Sizes now available for reasonably prompt delivery range from ¾" to 4" O. D. in lengths up to 40 feet. It is cold-formed from strip steel on modern, precision controlled equipment. Since the accurate gauge and width of the flat-rolled strip are controlled by very close tolerances, the O. D. and I. D. of the finished tube are concentric.

As no extra metal is added in the welding process, the grain structure of wall and weld is homogeneous. Physical properties are further improved by atmospheric annealing; this also produces a scale-free, bright finish which hides no defects on either inside or outside surface. Maximum strength of Talon's Electric Welded Steel Tubing is assured by hydrostatically testing every foot of pressure tubing for safety and by carefully inspecting mechanical tubing to meet your own individual requirements. Hence, Talon's Electric Welded Tubing meets A. S. M. E., S. A. E., A. S. T. M., A. B. S. and all standard government specifications.



TALON . . INC.

STEEL TUBE DIVISION **OIL CITY, PENNA.**

HOW AND WHY

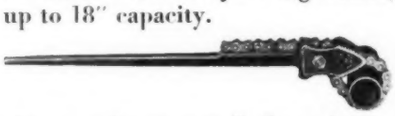
WILLIAMS' TOOLS AID WAR PRODUCTION

DATA ON "VULCAN" CHAIN PIPE TONGS

There are 6 types of Williams' Tongs, each offering certain advantages for particular classes of work. A knowledge of the features of these various types will enable users to better select the most efficient and economical type for the work at hand.

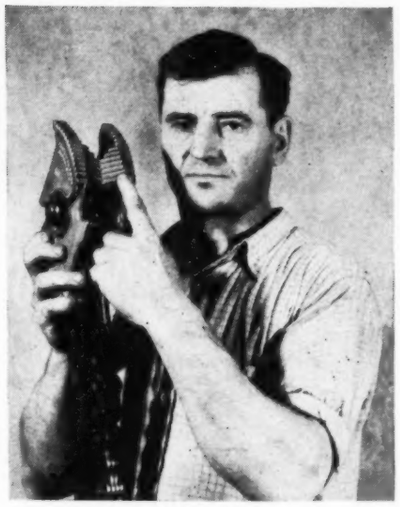
"VULCAN SUPERIOR": A universal service tong for *both* pipe and fittings. Has Reversible pipe-and-fittings jaw. Seven sizes, up to 12" capacity.

"VULCAN": The original "VULCAN" Pipe Tong — still the favorite oil-field tongs for general work. Chain swings from center and can be used on either side of the jaw. Eight sizes, up to 18" capacity.



"VULCAN SUPERTONG": Same design as "VULCAN" but forged from alloy and high-tensile steel. Provides 50% greater strength than "VULCAN" with no increase in bulk or weight. Eight sizes, up to 18" capacity.

"IMPROVED VULCAN": Same as "VULCAN" except jaws are double-ended and reversible, providing double service life. Seven sizes, up to 12" capacity.



The "V" recess in "Vulcan Superior" jaws assures quick, positive grip on fittings.

TYPES OF "VULCAN" CHAINS

While "VULCAN SUPERIOR" and "VULCAN" Tongs are furnished with *either* Flat Link or Cable Chain, all other types have Flat Link Chain only.

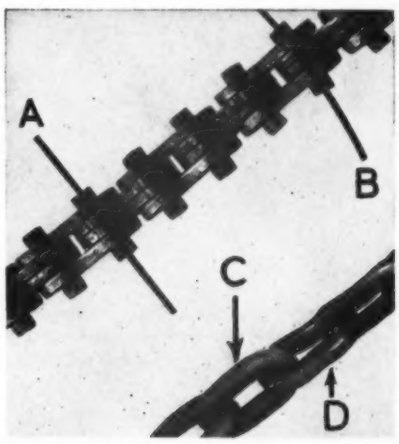
There are three types of Flat Link Chains for Williams' Tongs — "STANDARD", "XTRA-STRONG" and "SUPERCHAIN". "Standard" Chains are regularly furnished with all except "Supertongs" but "Xtra-Strong" Chains, providing approximately 40% greater strength, can be supplied at additional cost. "VULCAN SUPERTONGS" are regularly furnished with "Superchains". Every "VULCAN" Chain, regardless of type, is individually *proof-tested* on a standard tension machine to two-thirds of its breaking strain.

USE AND CARE OF TONGS

In using Chain Pipe Tongs the best gripping position is that which is midway of the jaw teeth, or rearward therefrom. The bending of the tong handle under load is not evidence of a defect. Such bending is intended to act as a warning and "safety valve" in advance of breakage of chain, which would incapacitate the tool.

In Flat Link Chains on tongs, an occasional inspection of the first two or three rivets and links adjacent to the swinging, or anchor link should be made, since the load is greatest at that point. Badly bowed, or curved rivets indicate that the chain has been loaded almost to breaking strength and is probably unsafe.

In Cable Link Chains, the links give warning by stretching and pulling "rigid" if the breaking point is approached.



A. Straight rivet indicates chain is safe.
B. Curved or bowed rivet — unsafe.
C. Safe link indicated by normal shape.
D. Link stretched or pulled "rigid" — unsafe.

WILLIAMS
SUPERIOR DROP FORGED TOOLS
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DROP-FORGINGS and DROP-FORGED TOOLS

Sold by Leading Industrial Distributors Everywhere . . . J. H. Williams & Co., Buffalo, N. Y.

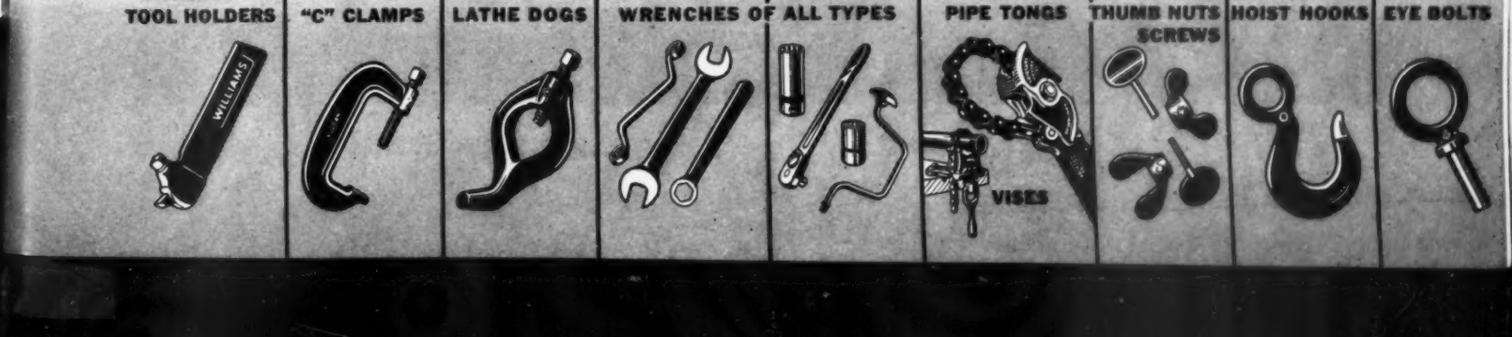

Fig. 3003—A Class 300 pound flanged end Cast Steel Gate Valve with outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Made in sizes 1″ to 24″, inclusive.

POWELL CAST ALLOY STEEL VALVES, for high temperature service, meet A.S.M.E. and A.P.I. Standards. They are made from regular cast steel valve patterns and are especially adapted for and used extensively in high pressure, high temperature oil refining processes. The designs also meet A. S. M. E. Boiler Code requirements. They are made to A. S. A. dimensions in the following pressure classes: 150, 300, 600, 1500 and 2500 pounds.

Molding the Character of a POWELL Valve

Development from "design" to "duty"—that's a critical stage in the life of a valve. In our foundries, Powell Valves, whether of bronze, iron, steel, pure metal, or special alloy, take on the form and substance that Powell Engineering has pre-determined will best fit them to perform the duties for which they are destined. Here under the watchful care of experts are molded the character-istics that have earned for Powell Valves the designation "Standard for Control." That's why today many industrial leaders are turning to Powell for the solution of all their valve control problems.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati, Ohio

POWELL VALVES

GOOD NEWS FOR THE OIL INDUSTRY!

Axelson *is building* *more* pumps

EACH MONTH WE'RE GETTING MORE MATERIAL WHICH ENABLES US TO STEP-UP AND SPEED-UP THE AMOUNT OF DELIVERIES

Not so long ago, we celebrated when a little batch of raw materials trickled into our plant and enabled us to build a few more pumps, or to replace parts on old ones. It was discouraging, but there was little or nothing to be done about it. The War Materials Board told us what we could have—and that was that!

Lately, however, the picture has changed as a result of requirements from the War and Navy Departments. They must have oil to run our rapidly expanding fleet; they must have high test gasoline to keep our incomparable bombers and pursuit ships in the air. War plants, munitions factories, engine builders are all demanding more oil, lest their machinery be shut down.

The red light has turned green; the regulations have been eased up a little more each month. So, Axelson is again in a position to step-up production. We are now making more pumps—not enough to meet the entire demand, as yet—but more than we made six months ago. We think this condition will steadily improve.

Meanwhile, our designers and engineers have performed miracles in creating new methods, using alternate materials—but never budging one iota from the traditional Axelson quality. We still believe we have the world's best pumps—and fifty years of experience have proved we're right!

Are you using any Axelson R.S.L. Pumps now?

Every pump manufacturer makes a Tube Type pump—but we believe Axelson R. S. L. type is the best insert pump made for all-over universal pumping requirements where the use of a rod type pump is indicated. These pumps are available in either traveling or stationary barrel types.

The patented Axelson top lock-hold-down, developed to provide positive anchorage and to prevent sandpacking in stationary barrel pumps, may also be used with the traveling type through the substitution of one part. In other words, by substituting a valve type manderel for the standard manderel in the hold-down, a traveling type pump can either be hung from the end of the tubing or can be set in the shoe above the end of the tubing. This is a typical feature, indicative of Axelson pump superiority. If you are not familiar with the various types and application of the Axelson R. S. L. pump, write for full particulars today.

FOR VICTORY—BUY U. S. WAR BONDS

Axelson

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INDUSTRIAL AGENCIES, LTD., 7 High St., San Fernando, Trinidad, British West Indies
C. C. MCDERMOND, Apartado 331, Maracaibo, Venez.

Make them yell 'Kamerad' again!

BUY *WAR SAVINGS BONDS*

When our boys went into action in 1918 the conquered Germans yelled "Kamerad", and line-ups of German prisoners similar to the photographs above were the rule in every sector.

Our government sold Liberty Bonds then . . . and we had meatless days . . . a scarcity of sugar . . . restricted travel . . . and all the other do's and don't's necessary to the winning of a war.

But today you have *WAR SAVINGS BONDS* to buy . . . bonds backed by our government's "promise to pay" . . . with a good rate of interest. *War Bonds* cannot depreciate in value. They are payable at face value . . . plus interest . . . to their *owner only*.

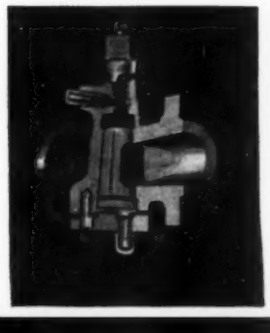
Let your savings not only pay you good dividends, but also help our boys make the Germans yell "Kamerad" again and the Japs their own particular word for it.

PUT ALL YOUR SAVINGS IN WAR BONDS—EVERY PAY DAY—FOR VICTORY!

REED ROLLER BIT CO.
HOUSTON, TEXAS

MAKING silk purses out of sow's ears is no longer a proverbial impossibility. Simi, riding his magic carpet through the air, is a piker alongside the P-38 Interceptor, the agility and lightness of which is due in a large measure to the use of light metal, combined with fine engineering. The oil wells of America can gush forth a thousand times more crude "latex" than all the rubber trees in the world. Glass a foot thick with perfect optical clarity is made from lime and alcohol derivatives. Cellulose acetate casts the cocoons of Japan into the discard. Truly, Aladdin has come to America. With the magic of syntheses, new products are born without cease or limit. Gas, oil, coal, cotton, cereals, with the help of catalysts and polymerizers, heat, pressure and chemico-mechanical action, produce the vital materials America needs. Significantly, all of these highly technical processes require Nordstrom Lubricated Valves to safely and precisely control the flow of gases, liquids and highly viscous substances. Newly-built magnesium, synthetic rubber and plastic plants have specified Nordstrom Valves for difficult control applications because only Nordstroms with patented *"Sealdport"* lubrication will satisfactorily serve. Lubrication is "the making" of dependable valve service.

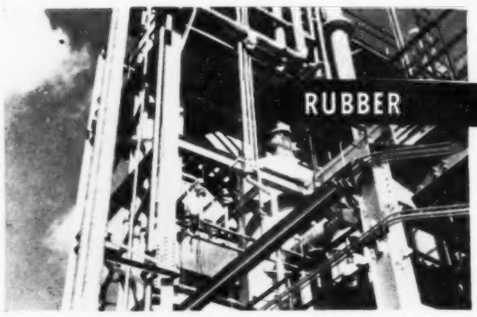
Processors of Synthetics invariably specify—



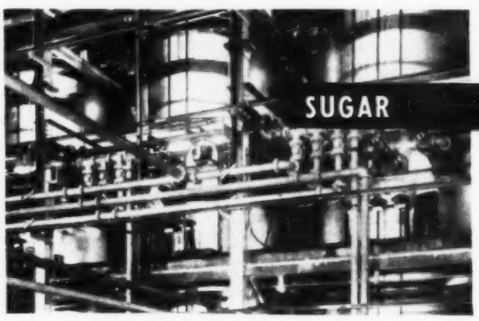
NORDSTROM VALVES

[BUY U.S. VICTORY BONDS]

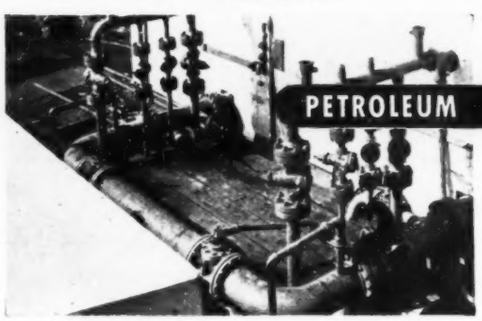
Nordstrom Valves in chlorine department of a magnesium plant.



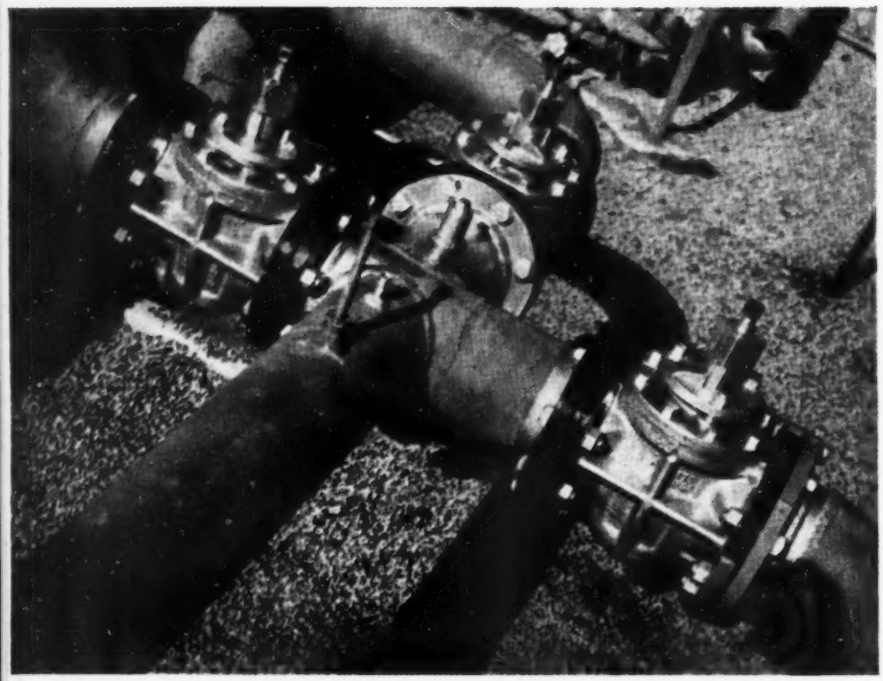
Nordstrom 14" Steel Valves on recovery tower in a synthetic rubber plant.



Nordstrom Valves in ion exchanger department of a Michigan sugar plant.



Nordstrom Valves on mud discharge manifolds and suction lines of a drilling rig.



Nordstrom 8" Valves in a gas plant.

Nordstrom Gear Operated Hypreseal Valves on dehydration lines.

Nordstrom Bronze Valves in acid treating plant.

Serving on the war front of production

The flow lines of industry are the life lines of production. Nordstrom Valves are the sentinels of control on the most vital lines. They are speeding production toward Victory.

•

KEEP UPKEEP DOWN

Nordstrom LUBRICATED VALVES

Sealdport Lubrication

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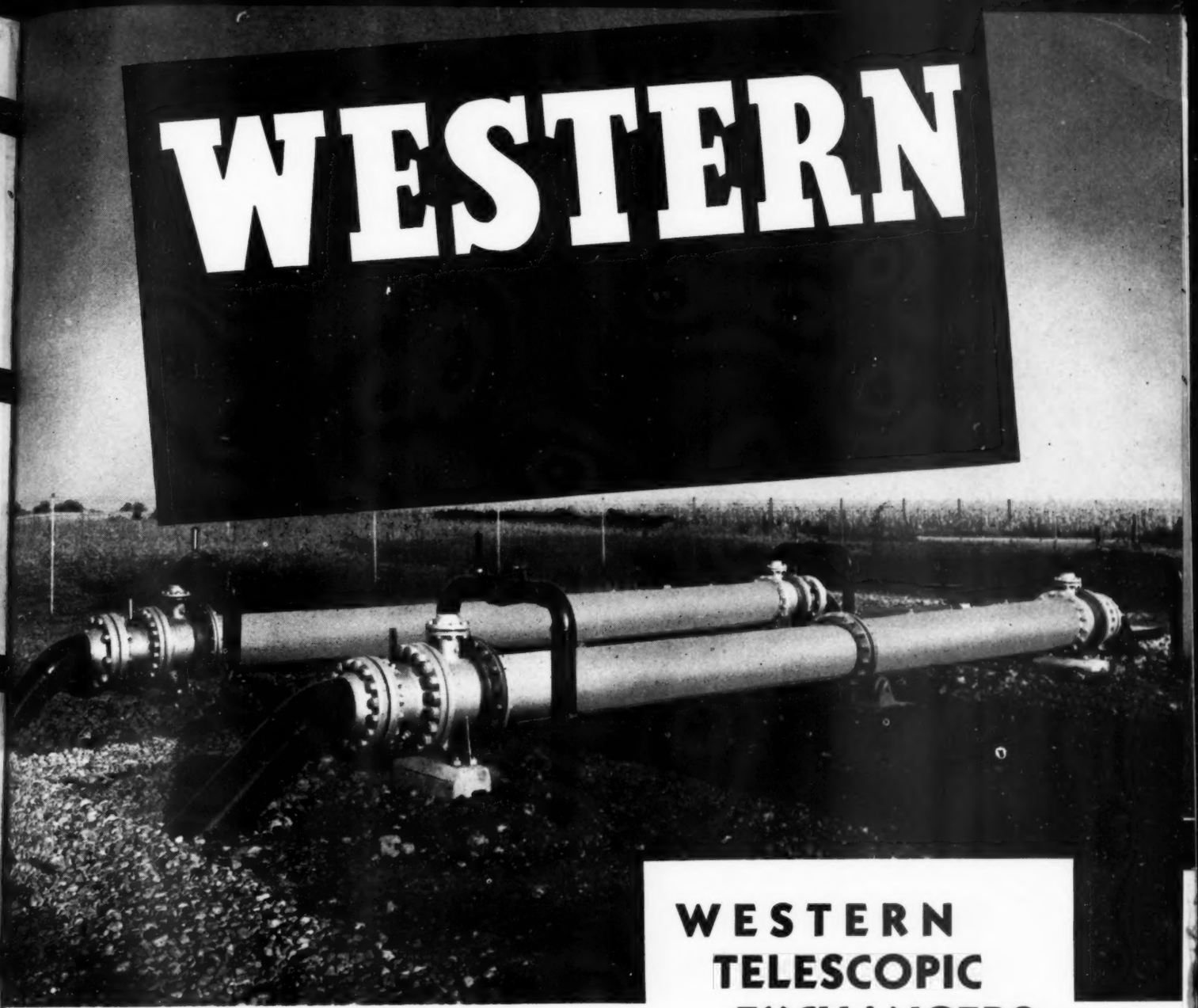
PRODUCTS: Nordstrom Lubricated Valves; Air, Curb and Meter Cocks • Nordco Valve Lubricants • EMCO Gas Meters • EMCO-McGaughy Integrators EMCO Regulators • Pittsburgh-National Meters for Gasoline, Grease, Oil, Water and other Liquids • Stupakoff Bottom Hole Gauges



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- Atmospheric Sections
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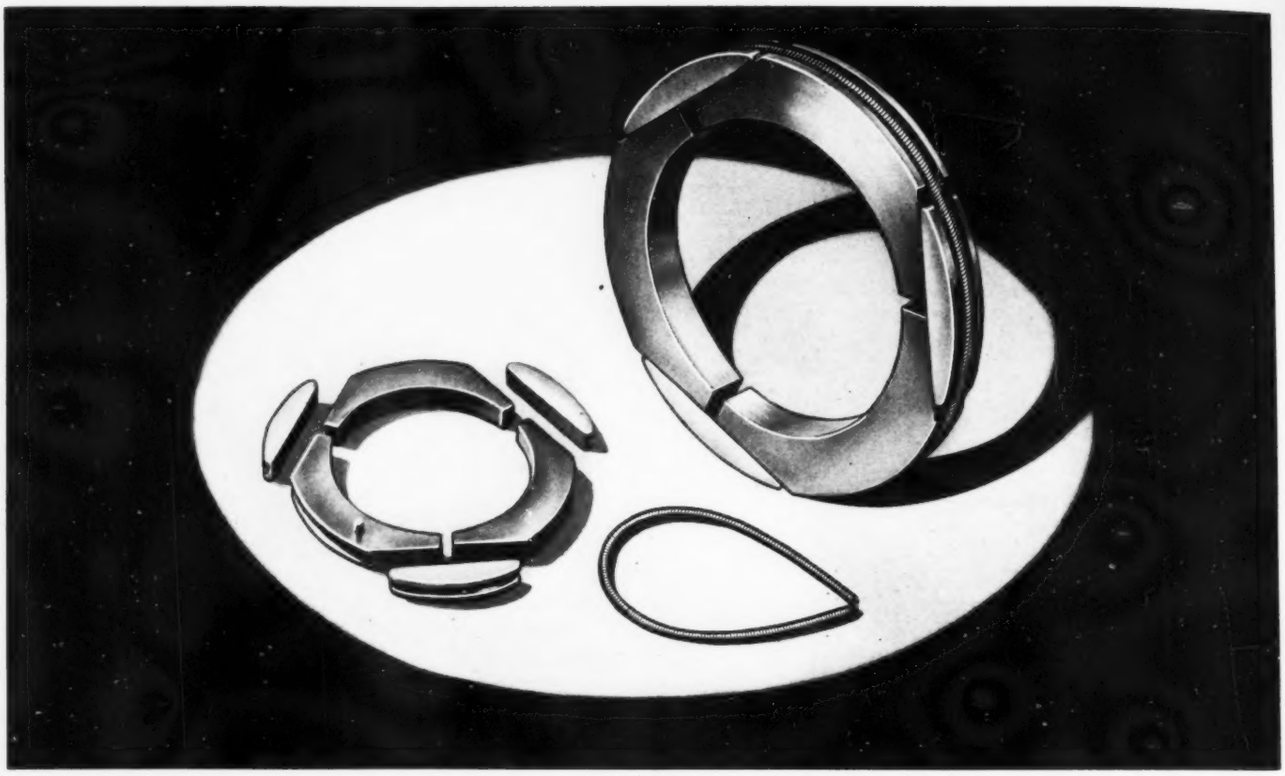
NOW!—particularly adapted for use in 100 OCTANE, SYNTHETIC RUBBER and other CHEMICAL PLANTS because their patented construction permits the use of LESS STRATEGIC, NON-CORROSIVE MATERIAL.

WESTERN SUPPLY CO.

P. O. Box 1888 **TULSA, OKLAHOMA** Phone: 8211 - L.D. 243



MODERN . . . *designs and materials*

Each set of COOK'S Metallic Packing is designed to suit the specific application. The style of packing ring and ring material to be used in each case, are determined by many variables, a few of which are pressure, temperature, nature of gas, lubrication, rod diameter and rod material.

Obviously with so many variables there is no universal packing ring. Take rod diameter for example. For a fixed set of conditions, one style of ring will serve best on a small diameter rod, while a different style gets the call for a large rod. The nearest approach to a universal ring is COOK'S Type "E" shown above, while below are a few other types.

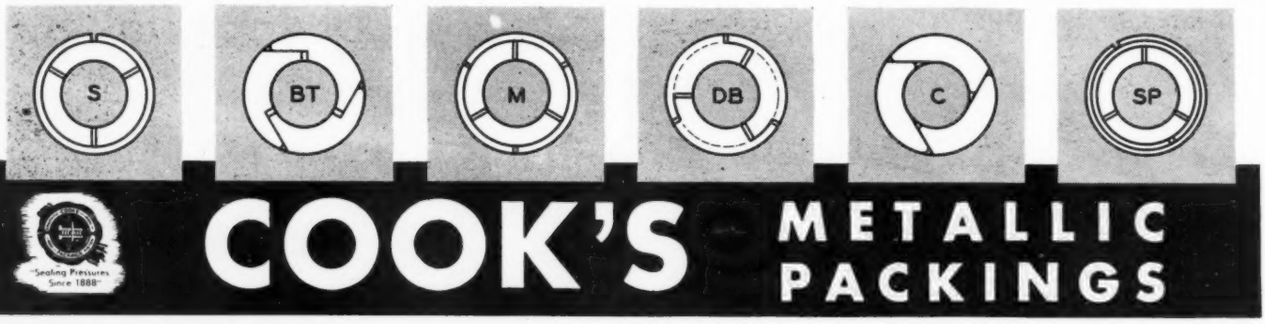
These are just a few of the many style rings engineered by COOK during the 55 years COOK'S Packings have served the builders and operators of compressors and engines.

Similarly COOK, unique in having its own foundry, has developed many exclusive materials including—COOK'S GRAPHITIC IRON in steam mix, compressor mix and a wide range of alloys, all with COOK'S exclusive "Tinized" surface treatment if required—COOK-MET in plastic, semi-plastic and other bronze compositions including white bronze (Babbitt)—in addition, non-metal materials, such as Carbon and Bakelite, either plain or graphitized, are frequently used.

Here at COOK, too, you will find the "know-how" and up-to-the minute practical experience in all kinds of packing applications to give you authoritative aid in selecting the right packings for your particular equipment and operating conditions.

So bring your packing requirements and problems to COOK. The nearest office will give you prompt, efficient service. You will be in good company, for all leading engine and compressor builders use COOK'S Packings. When you order new equipment, make sure you get the genuine by specifying COOK'S.

C. LEE COOK MANUFACTURING CO., Incorporated, Louisville, Kentucky. Branch Offices and Representatives —Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, Montreal, New Orleans, New York, Portland, Ore., San Francisco, Seattle, Tulsa.



"Sealing Pressures Since 1888"

COOK'S METALLIC PACKINGS

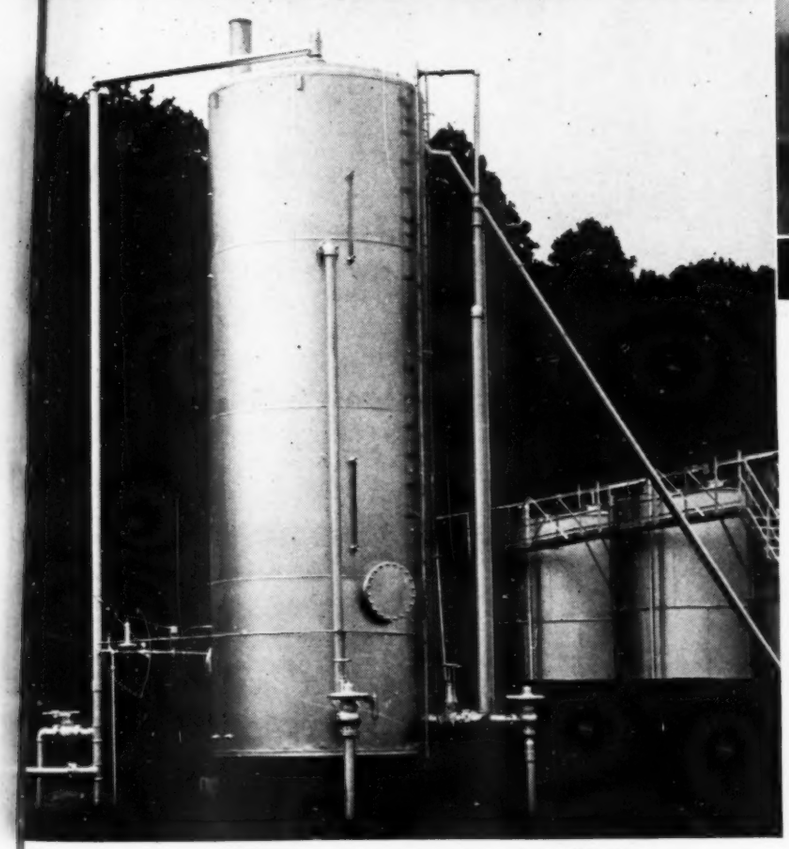
When WINTER COMES..

Use BS&B Heating-Treating Equipment

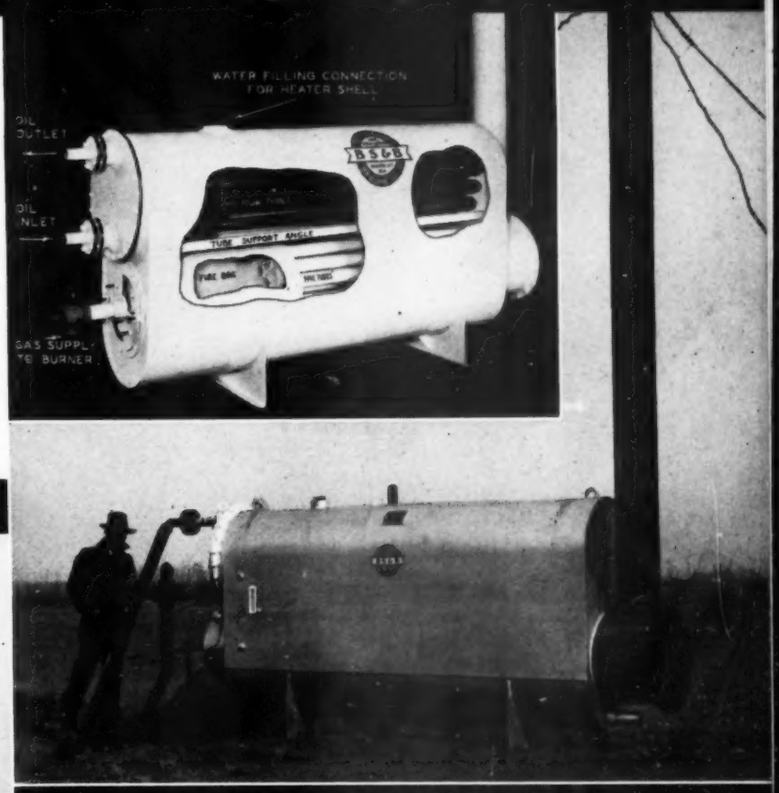
The utmost in single-unit treating plants. Provides complete separation of oil, gas and water; complete automatic operation. In sizes from 3 lb. to 25 lb. working pressure. Outstanding features include:

- Separation of free gas and free water in compact built-in free water knock out.
- Dependable high capacity heating unit; easily removed.
- Elimination of all gas forced out of solution by heat before oil reaches the settling chamber.
- Maximum length of emulsion travel through hot wash water.
- Adequate, quiet settling space.
- Built-in heat exchange for lower outlet temperature and conservation of gravity.

STAGE TREATING UNIT



B S & B 8' x 24' Stage Treating Unit in Illinois



INDIRECT HEATER

B S & B Indirect Heaters. Insert shows cross section of internal construction.

Heats Corrosive Oil or High Pressure Gas with Safety. Designed specifically for careful water bath heating. Fresh water transfers heat from fire tubes to oil tubes, eliminating all chances of overheating. Compact design for easy portability and quick installation. Economically constructed for long life. Outstanding features include:

- Safe, dependable, high capacity heating elements which heat clean fresh water, eliminating hot spots, coking and salt depositions.
- Cast iron flow tube coils for heating of corrosive fluid.
- Flow tube coils of seamless steel pipe and forged steel return bends up to 5,000 lbs. w.p. for heating high pressure gas to prevent formation of gas hydrates. Tubes stress-relieved after fabrication; tested to one and one half times w.p.
- Automatic dependable temperature controller.

Black, Sivalls & Bryson

BS&B

(INC.)

OKLAHOMA CITY

OTIS TUBING

Actual Photographs of a Perforated Section shows the Simplicity, yet Positive Precision of this New OTIS Method

1. A s
the tapere
tortion and

perated on an ordinary steel measuring line, the OTIS PERFORATOR is basically the same s used successfully by OTIS for the past s. The accompanying unretouched ive a clear, actual size illustration e of perfection that has been t is being so widely used.

2. An inside view shows the marks left by the special ing device which positively locks the tapered insert in pl The perforating tool is designed so that it drives the inse 1/32" beyond the inside diameter of the tubing. Further jarring crimps or brads the edge of the tubing over the back of the insert, securely locking it in place.

3. This view illustrates the perfectly round and full opening bore maintained in the tubing. There are no shoulders or restrictions to prevent swabbing or the running of bottom hole pressure gauges, paraffin scrapers or other sub-surface tools.

Petro-Chem

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RADIANT-CONVECTION TYPE)

UNLIMITED

IN SIZE OR CAPACITY

....PREFABRICATED....

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Patents Issued and Pending

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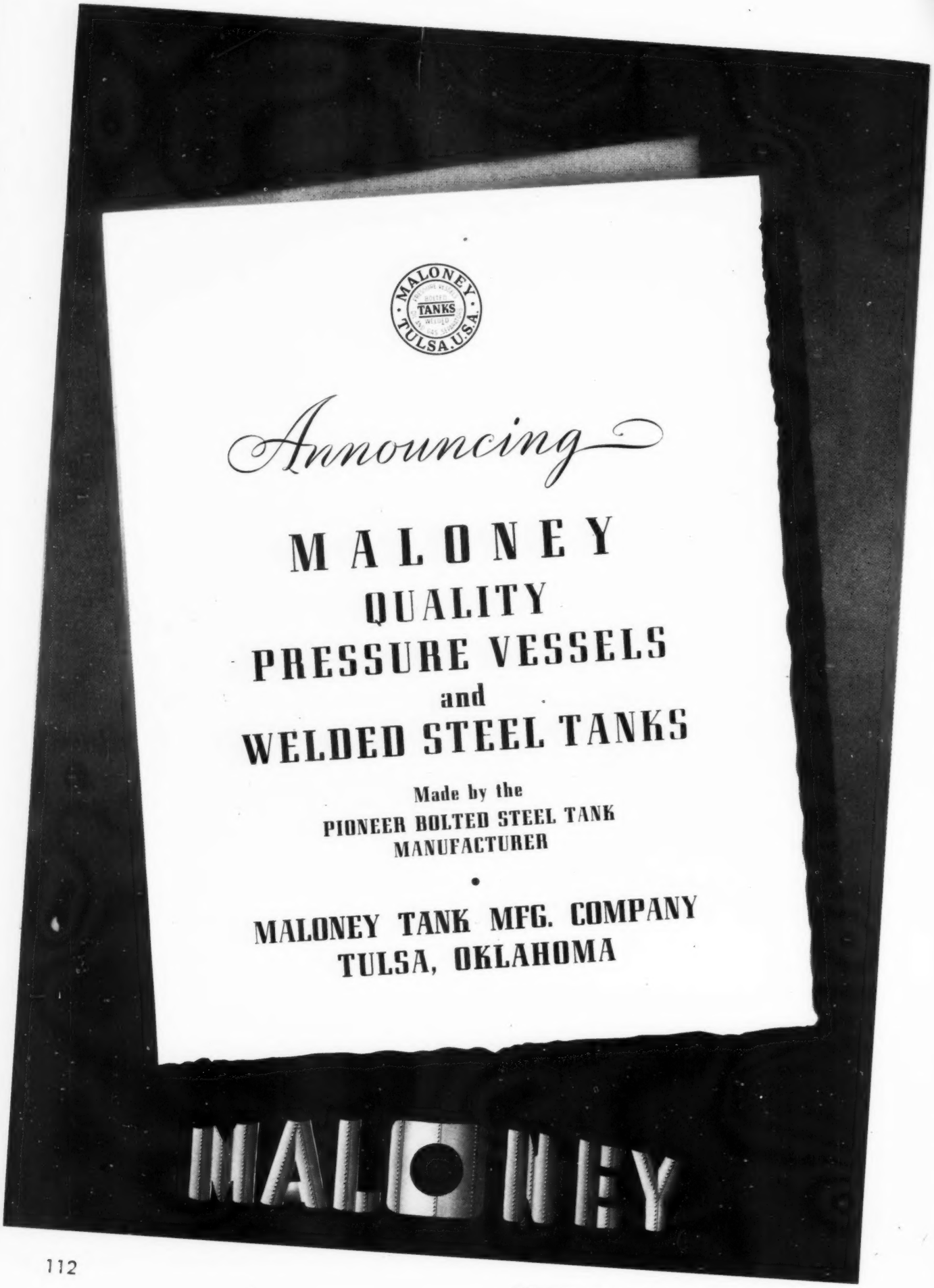
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PRESSURE VESSELS
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PIONEER BOLTED STEEL TANK
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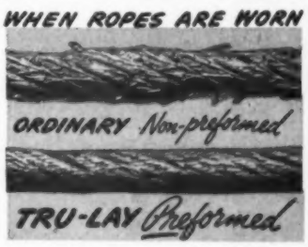
MALONEY

30% OF ALL INDUSTRIAL ACCIDENTS ARE TO HANDS AND FINGERS

According to the National Safety Council, 30% of all time-out, industrial accidents are to fingers and hands. 20% of these accidents result in infections. And a workman who has lost his hand through infection is just as incapacitated as if he had lost it in a punch press or buzz saw.

We hope you have never had a lost-time accident due to wire rope. Some operators have, however, and 1943 is no time to have workmen laid up with blood-poisoned hands. Many operators have drastically reduced accidents (and compensation claims) by adopting American Cable TRU-LAY Preformed—the safer rope.

Being preformed, American Cable TRU-LAY is tractable—flexible—easy to handle. It resists kinking and snarling. Worn or broken crown wires lie flat and in place—refusing to wicker out to puncture hands or tear clothing...Furthermore, being preformed, TRU-LAY will last longer than ordinary cable. It has far greater resistance to bending fatigue. That means reduced machine shutdowns for replacement—steadier production — greater dollar value. . . . All American Cable ropes identified by the Emerald strand are made of Improved Plow Steel.



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ESSENTIAL PRODUCTS . . . TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, Yacht Rigging, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*

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